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# The Engineer.

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VOL. CXXXIX.—No. 3610] LONDON: FRIDAY EVENING, MARCH 6, 1925 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

## The Engineer

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### PUBLIC NOTICES

**The Director - General,** India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

1. STEAM ROAD ROLLERS.
2. CARTRIDGE HEADING PRESSES, Belt driven.
3. MACHINES, MILLING, UNIVERSAL and VERTICAL, Brown and Sharpe Nos. 2A and 2, or equal.

Tenders due on the 17th March, 1925, for No. 1, and on the 27th March, 1925, for Nos. 2 and 3.
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INDIAN SERVICE OF ENGINEERS, STATE RAILWAYS.

**The Secretary of State** for India in Council will in 1925 APPOINT TWO ASSISTANT EXECUTIVE ENGINEERS for this service, if so many suitable candidates present themselves.

Every candidate must be a British subject, or a ruler or subject of any State in India in respect of whom the Governor-General of India in Council has made a declaration that he is to be considered eligible.

Candidates must be not less than 21 years, and not more than 24 years of age on 1st August, 1925.

They must either (1) have obtained one of certain recognised University Degrees or other distinctions in Engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such Examination, or (3) produce the required evidence that they are otherwise eligible under the Regulations. They must in addition have had at least one full year's practical experience of Civil Engineering under a qualified Civil Engineer at the time when they appear before the Selection Committee.

Applications from candidates must reach the India Office not later than 1st April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1. 8184

INDIAN SERVICE OF ENGINEERS.

**The Secretary of State** for India in Council will in 1925 APPOINT 8 ASSISTANT EXECUTIVE ENGINEERS for this Service if so many suitable candidates present themselves.

Every candidate must be a European British subject and must be not less than 21 years and not more than 24 years of age on 1st August, 1925.

They must either (1) have obtained one of certain recognised University Degrees or other distinctions in Engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such Examination, or (3) produce the required evidence that they are otherwise eligible under the Regulations. They must in addition have had at least one full year's practical experience of Civil Engineering under a qualified Civil Engineer at the time when they appear before the Selection Committee.

Applications from candidates must reach the India Office not later than 1st April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1. 8240

**Assistant Engineers Required** for the GOLD COAST GOVERNMENT CENTRAL PROVINCE RAILWAY CONSTRUCTION for a tour of 12 to 18 months' service, with possible extension. Salary £480, rising to £720 a year by annual increments of £20. Field allowance of £90 a year whilst carrying out duties in the Colony. Free passages and liberal leave on full salary. Candidates, not over 40 years of age, must be fully trained civil engineers and be proficient in the use of the transit and level. Must have ability to do ordinary draughting and compiling estimates, and be able to set out work and generally supervise erection of concrete and steel work.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/12,449. 8519

**Assistant Engineer Required** for the GOVERNMENT of HONG KONG for the PUBLIC WORKS DEPARTMENT for three years' service, with possible permanency. Salary £440, rising to £500 a year by annual increments of £20 and thence (if appointment is made permanent) to £1000 a year, payable locally in dollars at the Government rate of exchange, which is at present fixed at 2s. to the dollar. In addition a strictly temporary exchange allowance of 20 per cent. of salary is at present paid, and thus at the present time the annual salary in dollars will be 5520 dollars a year. The current rate of exchange being worth about 2s. 4d. to the dollar, the sterling equivalent of 5520 dollars is accordingly about £600. Travelling allowance at the rate of 240 dollars a year. No income tax payable. Free passages. Candidates, preferably unmarried, 24-30 years of age, must be regularly trained civil engineers and have passed the Institution of Civil Engineers' examination or have obtained exemption therefrom by an exempting degree. Must be good draughtsmen, proficient in land surveying and levelling. Should preferably have had experience in maintenance work of waterworks of a large town and some experience in waterworks construction.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/12,411. 8578

**Required for Service** under the GOVERNMENT of INDIA (1) FOREMAN TOOL MAKER, for Gun Carriage Factory, Jubbulpore (Appointment 40).

Must have served regular apprenticeship in large engineering works in Great Britain and have had at least 8 years' specialised experience in up-to-date tool, jig and die design and manufacture. Must be conversant with latest practice in hardening and best treatment of tools. Age preferably between 30 and 35 years.

(2) FOREMAN WORKS INSPECTION (GUN) for Gun and Shell Factory, Cossipore (Appointment 43).

Must have served regular apprenticeship and have had not less than 10 years' experience in gun manufacture ranging principally from 12 pr. to 6in. Must have knowledge of gun making and design and have had actual experience in the inspection of ordnance.

Terms (in each case), agreement for 5 years in the first instance. Salary at the rate of Rs. 575, rising by annual increments of Rs. 20 to Rs. 655 per calendar month, with prospects of further increases. Free second-class passage to India and return passage on satisfactory termination of services. Free quarters.

Further particulars and forms of application may be obtained from the SECRETARY to the HIGH COMMISSIONER for INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 14th March, 1925. 8520

### PUBLIC NOTICES

**Architect Required by** the GOVERNMENT of SIERRA LEONE in the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' continuous residential service. Salary £600 a year. Free quarters and passages and liberal leave on full salary. Candidates, aged 28-35, should have served articles with a member of the Royal Institute of British Architects and have passed the examination qualifying for associate membership of that Institute, or possess the diploma of some recognised college which is accepted by that Institute as exempting candidates from taking the examination of the Institute. Must be first-class draughtsman, capable of designing and carrying out buildings, taking out quantities, preparing details and specifications, and must be competent to execute building surveys, set out buildings and lay out roads.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13,190. 8518

**Section Engineers (4) Required** for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS for three years' service, with possible extension. Salary 400 dollars a month, rising to 475 dollars a month by annual increments of 25 dollars a month, plus a temporary non-pensionable allowance of 10 per cent., which is liable to cancellation or revision, plus a commuted field allowance of 80 dollars a month. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passages provided. On expiration of agreement a bonus of four and a-half months' salary may be allowed, provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age 23 to 30, unmarried, must have passed examination to qualify for Associate Membership of the Institution of Civil Engineers or hold equivalent professional qualifications, have served an engineering apprenticeship on a home railway, and preferably possess some subsequent experience on railway construction or maintenance. In the event of the selection of a candidate who has not attained the age of 25, he will only receive a salary of 350 dollars a month until he has attained that age.—Apply at once by letter, stating age and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at top of application M/13,264. 8579

**Administrative County of LONDON.**
REMOVAL OF SEWER DEPOSIT.

The London County Council invites TENDERS for the REMOVAL and DISPOSAL of SEWER DEPOSIT and other materials in connection with the main drainage, &c., services for four districts, two north of the Thames and two south of the Thames, east and west respectively, for a contract for twelve months, commencing 1st April, 1925.

Persons desiring to submit Tenders may obtain the schedule of prices, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £1. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained upon personal application and the contract documents may be inspected before payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 16th March, 1925, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
8525 Deputy Clerk of the London County Council.

### PUBLIC NOTICES

**Administrative County of LONDON.**
NORTH-WESTERN STORM RELIEF SEWER.
CONTRACT NO. 2.

The London County Council invites TENDERS for the CONSTRUCTION of a 7ft. 6in. and 8ft. 6in. internal diameter SEWER in BRICKWORK or CAST IRON, of a total length of about 7180ft., from Kilburn-park-road to Clarendon-road; also a 4ft. 6in. internal diameter BRANCH SEWER in BRICKWORK, of a total length of about 2780ft., from Ladbroke-grove to Tavistock-crescent; and a 5ft. internal diameter BRANCH SEWER in BRICKWORK, of a total length of about 5340ft., from Scrubbs-lane to Cumwall-road, including WEIR CHAMBERS, TUMBLING BAYS, MANHOLES, VENTILATORS, SIDE ENTRANCES, &c., in the Metropolitan Boroughs of Paddington, Kensington and Hammersmith, and the Urban District of Willesden.

Persons desiring to submit Tenders may obtain the form of Tender and contract, specification, bill of quantities and drawings on application, on and after Monday, 2nd March, 1925, to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £10. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after Twelve Noon on Tuesday, 24th March, 1925, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
8526 Deputy Clerk of the London County Council.

**Bethnal Green Board of GUARDIANS.**
HYDRAULIC PUMP.

The Bethnal Green Board of Guardians invite TENDERS for the SUPPLY and INSTALLATION of a HYDRAULIC PUMP for their Hospital in Cambridge-road, Bethnal Green.

Forms of Tender and specifications may be obtained from the undersigned by forwarding a stamped addressed foolscap envelope.

Tenders must be returned in time to reach the undersigned not later than Twelve Noon on Tuesday, 17th March, 1925.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order,
C. FAULKNER JONES,
Clerk to the Guardians.
Guardians' Administrative Offices,
Bishop's-road, E. 2.
March 4th, 1925. 8565

**Metropolitan Asylums Board.**

The Board invite TENDERS for the REMOVAL of existing HEATING APPARATUS and the PROVISION and FIXING of NEW HEATING APPARATUS at Caterham Mental Hospital, Caterham, Surrey, in accordance with the specification and drawings prepared by Mr. T. Cooper, M. Inst. C.E., M.I. Mech. E., Engineer-in-Chief. The specification, drawings, and form of Tender may be inspected at the office of the Board, Victoria Embankment, E.C. 4, on and after 10 a.m. on Thursday, 5th March, and can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a bona fide Tender sent in accordance with the instructions on the form of Tender and after the specification and the drawings have been returned.

Tenders, addressed as noted on the form, must be delivered at the office of the Board not later than 2.30 p.m. on Wednesday, 25th March, 1925.

G. A. POWELL,
8516 Clerk to the Board.

### PUBLIC NOTICES

**Clyde Navigation.**
TO SHIPBUILDERS.
STEAM HOPPER BARGES.

The Trustees of the Clyde Navigation invite TENDERS for TWO TWIN-SCREW STEAM HOPPER BARGES, of 1500 Tons capacity, or, alternatively, of 1500 Tons capacity.

On and after 9th inst., drawings may be seen and copy of the specification and form of Tender obtained on application at this office to Mr. Daniel Fife, Mechanical Engineer, on payment of £2 2s., which will be refunded on receipt of a bona fide Tender.

Sealed Tenders, marked "Tender for Hopper Barges," to be lodged with the undersigned not later than Noon on Monday, 6th April next.

The Trustees may not accept the lowest or any Tender.

T. R. MACKENZIE,
General Manager and Secretary.
16, Robertson-street, Glasgow,
5th March, 1925. 8577

**The Derwent Valley Water BOARD.**
PIPE TO FILTERS.

The Derwent Valley Water Board is prepared to receive TENDERS for the LAYING of about 10,000 YARDS of 48in. STEEL PIPES, lined with Concrete, and the VALVES, STREAM CROSSINGS, &c., connected therewith.

The specification and schedule of prices and copies of the drawings may be obtained on application to Mr. S. B. Wineer, M.I.C.E., Engineer to the Board, at these offices, on and after Monday, 9th March, on payment of Two Guineas, which will be returned on receipt of a bona fide Tender and the documents furnished by him.

Sealed Tenders, enclosed in the envelope supplied with the documents, to be delivered not later than Nine o'clock on Monday morning, the 23rd of March.

The Board will not be bound to accept the lowest or any Tender.

O. B. STEWARD,
Clerk to the Board.
Bamford, near Sheffield,
23rd February, 1925. 8495

**The South Indian Railway COMPANY, LIMITED.**

The Directors are prepared to receive TENDERS for the SUPPLY of—

1. STEEL FISH-PLATES.
2. FISH-BOLTS, NUTS and WASHERS.
3. STEEL BEARING PLATES for F.B. RAILS.
4. STEEL CRANKED FISH-PLATES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Fish-Plates," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 20th March, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specification No. 1, 5s. for each copy of Specification No. 2, and 2s. 6d. for each copy of Specification Nos. 3 and 4.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 5, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France,
3rd March, 1925. 8564

**Corporation of Harwich.**
FACTORY SITE.

The Corporation are prepared to LET on a Long or Short Lease a SITE eminently suitable for a factory.

The site is situate in Dovercourt and includes a chimney 250ft. in height.

The site abuts upon the railway and River Stour and the lease would include the right to use the dock in the immediate vicinity.

Area about two acres.

Further particulars can be obtained from the undersigned.

A. J. HANSLIP WARD,
Town Clerk.
Harwich, 20th February, 1925. 8458

**The Urban District Council of ABERDARE.**
FOR SALE.

Due to the closing down of Refuse Destructor Station, the Council invite OFFERS for ONE 200 K.W. and ONE 100 K.W. DIRECT-CURRENT STEAM GENERATING SET.

Full particulars will be supplied on application to the undersigned.

W. T. HILDER, M.I.E.E.,
Engineer and Manager.
Electricity and Tramways Dept.,
Aberdare, Glam.,
18th February, 1925. 8463

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## PUBLIC NOTICES

**The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.**

The Directors are prepared to receive TENDERS for (i) FITTINGS for CAST IRON SLEEPER POTS for B.S. 90 lb. BULL-HEADED RAILS, comprising—

| | | | | |
|---|---|---|---|---|
| 67,200 | Wrought iron | Tie-bars, approx. wt. | 945 | tons. |
| 134,500 | .. | Cotters, .. | 35 | .. |
| 134,500 | .. | Gibs, .. | 18 | .. |
| | | Total approximate weight .. | 998 | .. |

(ii) 618,600 STEEL DOG-SPIKES for B.S. 60 lb. F.F. RAILS (approx. weight, 166 tons).

In accordance with the specifications, which may be seen at the offices of the Company. The charge for each of the specifications is One Guinea (£1 1s.), which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 24th March, 1925, and marked "Tender for Sleeper Fittings," or as the case may be.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices,
25, Buckingham Palace-road, Westminster, S.W. 1.
3rd March, 1925. 8562

**Singapore, Straits Settlements.**
WATER DEPARTMENT.
ASSISTANT ENGINEER.
ADVERTISEMENT.

The Municipal Commissioners of Singapore REQUIRE an ASSISTANT WATER ENGINEER, age 25-30, unmarried, on a four years' agreement, with possible extension. He must have had a good technical education, a regular training as a civil engineer, and have a practical knowledge of surveying, levelling, and estimating, and at least three years' experience in works of water supply. Preference will be given to an Assistant who has passed the examination of the Institution of Civil Engineers as Assoc. M. Inst. C.E. The Testamur by examination of the Institution of Municipal and County Engineers will be an advantage.

Salary 5400 dollars for the first, 5700 dollars for the second, 6000 dollars for the third, and 6300 dollars for the fourth year, paid monthly in dollars, the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. The pay of the appointment for the first year at this rate would be £630. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass a medical examination.

Applications, stating whether married or single, age, and place of birth, and giving details of education, training, and experience, particularly in water works, and referring to all the above requirements in detail, accompanied by copies (only) of testimonials, and also personal references, must be lodged with Messrs. PRICE and WILLIAMS, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 10th March, 1925. 8471

**The Commissioners for the PORT OF CALCUTTA.**

REQUIRED IMMEDIATELY for India, a DRAUGHTSMAN, with a good knowledge of Culverts, Penstocks, Pumping Stations, Granite Details, &c., in connection with Docks.

Salary about Rs. 700 per month. Only experienced men should apply.—Send references, copies only, to the Commissioners' Consulting Engineer and London Agent, Mr. J. ANGUS, 10, Princes-street, Westminster S.W. 1. 8561

**The Corporation of Trinity HOUSE.**

APPOINTMENT OF ASSISTANT ENGINEER.

APPLICATIONS are INVITED for the APPOINTMENT of an ASSISTANT ENGINEER. Age 28 to 35.

Candidates must be A.M.I.C.E. by Institution or equivalent examination. They should be quick and neat draughtsmen, proficient with theodolite and level, able to draw up complete specifications, take out quantities, and write reports. A thorough knowledge of building construction, ferro-concrete, steel structures and sea works essential. General all-round knowledge of engineering, including electrical and wireless work, is a qualification.

Commencing salary £400 per annum, rising to £600 per annum, plus bonus.

Applications, stating age, qualifications and experience, accompanied by copies of not less than three testimonials, to be addressed to the SECRETARY, Trinity House, London, E.C. 3, not later than the 20th March, marked outside "Applications re Assistant Engineer." 8559

## SITUATIONS OPEN

WANTED by a Photographic Paper Coating Firm, a suitable YOUNG MAN with Engineering knowledge, capable of taking charge of small works; must have some knowledge of Photography. Good opportunity for one capable of undertaking the work. —Address in first instance with full particulars, experience, credentials, and salary expected, P363, The Engineer Office. P363 A

AIRCRAFT INSPECTOR WANTED. Man with sound experience of all Aircraft Inspection, including Timber and Metal Details, Components, Final Inspection of Complete Machine, &c. For factory in Southern Europe. Full particulars.—Address, 8536, The Engineer Office. 8536 A

ENGINEER (About 30) WANTED; Experience of Woodworking, Builders' and Contractors' Plant and Salesmanship, new and second-hand. London area. State age, experience, and salary required.—Address, 8573, The Engineer Office. 8573 A

ENGINEER WANTED, Take Sole Charge Plant. Good salary and free board and lodging for self and family. Investment £250 secured.—Address, P364, The Engineer Office. P364 A

ENGINEER, with Knowledge of Accounts, REQUIRED to Take Charge of Cost Office in Light Engineering Works, London district.—Address, giving details of experience, age, salary required, &c., 8571, The Engineer Office. 8571 A

HEATING ENGINEER, for Large Firm in Lancashire; must be thoroughly practical and accustomed to Supervising Erection and handling workmen. State age and experience and salary required. —Address, 8534, The Engineer Office. 8534 A

SALES ENGINEER REQUIRED by South Yorkshire Firm of Furnace Specialists, for developing sales of Producer Gas-fired Lime Kilns. Must have experience and suitable connection.—Address, stating age, experience, references, &c., and remuneration required, 8568, The Engineer Office. 8568 A

SEARCHER for PATENT OFFICE, with Technical knowledge, REQUIRED by Patent Agents. Salary one hundred and sixty guineas.—Address, with age and experience, P349, The Engineer Office. P349 A

WORKS MANAGER WANTED for Large Structural Works in London. Must have held a similar position and be able to handle men and turn out work expeditiously. State age, experience, and salary required.—Address, P340, The Engineer Office. P340 A

WANTED, by Engineering Firm in North Midlands, experienced DRAUGHTSMEN, with good knowledge of General Engineering; must be capable of Preparing Working Drawings from preliminary designs and able to make the necessary Calculations. —Address, stating experience and salary required, 8522, The Engineer Office. 8522 A

## SITUATIONS OPEN (continued)

WANTED IMMEDIATELY, DRAUGHTSMAN, Constructional, used to Steel-frame Buildings design and detail; theoretical knowledge essential; age 25 to 35.—Reply, giving full details of experience and salary required, to CHIEF ENGINEER, Drew-Bear Parks and Co., Ltd., Wellington-road, Battersea, S.W. 8570 A

WANTED IMMEDIATELY, First class DRAUGHTSMAN, Heavy Machinery and Structural Steel Work. Must have good experience and references. London area.—Address, 8548, The Engineer Office. 8548 A

CHIEF DRAUGHTSMAN.—VACANCY Exists in Engineering Firm in Belfast manufacturing specialities. Capable of handling multiplicity of small contracts expeditiously. Must be good organiser and strict disciplinarian. Staff about 24. Only experienced first-class man will be considered. Replies strictly confidential.—Address in first instance, stating age, experience, and salary required, 8388, The Engineer Office 8389 A

CIVIL ENGINEERING DRAUGHTSMAN REQUIRED temporarily. Must have good knowledge of Hydraulics and experience in design of Reinforced Concrete Structures. State age, experience, and salary required.—Address, 8546, The Engineer Office. 8546 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 66, St. George's-square, London, S.W. 1. 7871 A

DRAUGHTSMAN DESIGNER WANTED by Important Firm making Steam Engines and Pumping Machinery. For a live man with initiative and ability this is a good opening.—Address, giving full experience, age, and salary required, 8560, The Engineer Office. 8560 A

DRAUGHTSMAN, Having Sound Experience in Steam Turbine Work.—Address, stating age, previous experience and salary required, with copies of references, 8388, The Engineer Office. 8388 A

DRAUGHTSMAN REQUIRED, with Good Experience of design of Semi-Diesel and Cold-starting Oil Engines.—Apply, stating age, salary, and full particulars, to W. H. ALLEN, SONS and CO., Ltd., Bedford. 8549 A

DRAUGHTSMAN, SENIOR, with First-class Experience on Power or Instrument Transformer Work. —Address, stating age, qualifications, and salary required, and earliest date could commence, 8550, The Engineer Office. 8550 A

DRAUGHTSMAN (TEMPORARY), with Experience in Marine Engine Auxiliaries; London area. State salary.—Address, 8535, The Engineer Office. 8535 A

DRAUGHTSMEN WANTED by Firm of Westminster Engineers. Must have thorough knowledge and experience of works in connection with Dock, Harbour and large Public Works Contracts.—Apply, giving full particulars of age, experience, and salary required, to Box 547, c/o Brown's, Tothill-street, Westminster, S.W. 1. 8561 A

DRAUGHTSMAN WANTED by Firm in the Midlands manufacturing Municipal Vehicles. Applicants should state age, experience, and salary required, and enclose copies of references.—Address, 8539, The Engineer Office. 8539 A

DRAUGHTSMAN, Well Accustomed to Detailing Constructional Steel Work, REQUIRED by a London Firm. State age, experience, and salary, &c. —Address, P347, The Engineer Office. P347 A

DRAUGHTSMAN WANTED, Experienced in Gas and Chemical Plant; must be familiar with Purification Plant, including Condensers, Purifiers, &c., and complete By-product Installations. State salary, experience, and when at liberty.—Address, 8462, The Engineer Office. 8462 A

FIRST-CLASS DRAUGHTSMAN REQUIRED, with experience in Hydraulic Appliances preferred. State age, experience, and salary.—Address, P359, The Engineer Office. P359 A

FIRST-CLASS JIG and TOOL DRAUGHTSMAN REQD. by Firm Mnfg. High-class Switchgear and Rly. Signalling Gear; must have thor. knowledge Machine Tools and exper. of up-to-date Shop Methods. State age, exper. and sally. reqd.—Address, 8524, The Engineer Office. 8524 A

MECHANICAL DRAUGHTSMAN WANTED. Must have been through shops. State age, experience, salary, when take up duties. Copies refs. (not returnable). Constancy for energetic man; one hour from London.—Address, 8473, The Engineer Office. 8473 A

MESSRS. REAVELL and CO., Ltd., Ipswich, REQUIRE an experienced DRAUGHTSMAN, capable of taking charge of that section of their drawing-office dealing with Reciprocating Compressors. Give full career with dates and particulars of technical training. State age and salary required. 8572 A

REQUIRED for English Engineering Works in India, an ENGINEER DRAUGHTSMAN, with good theoretical training, capable of designing Cranes, Lifting Appliances, Sluices, preparing estimates and drawings for Mill Gearing, and with good knowledge of Machine Shops Practice.—Apply, stating age and giving full particulars, to "Z.B. 976," c/o De Jong's Advertisement Agency, Leadenhall-street, London, E.C. 3. 8558 A

TEMPORARY CIVIL ENGINEERING DRAUGHTSMAN REQUIRED; neat, quick and accurate; good leveller and surveyor. Student Inst. C.E. preferred. Salary £4 10s. per week.—Address, 8479, The Engineer Office. 8479 A

TWO FIRST-CLASS STEELWORK DESIGNERS REQUIRED IMMEDIATELY, with good theoretical and practical training in the Calculations, Details and Drawings for Steel-framed Buildings and other Structural Steelwork.

Only competent designers with experience in Contractors' Works will be considered, and preference will be given to those having also Designing Experience in Timber Structures, Foundations and Retaining Walls.

Candidates must have served in H.M. Forces during the War.—Applications, in writing, not later than 14th March, to Box T.G., Charles Barker and Sons, Limited, 31, Budge-row, E.C. 4, with not more than three copies of recent testimonials and particulars of training, experience, age, salary required and service in Forces. 8517 A

WANTED, PRINCIPAL FOREMAN, to Take Charge of Department manufacturing Steam Main Pipes from Lap-welded Tubes up to 16in. diameter. Must have excellent knowledge Acetylene Electric and Fire Welding, Modern Bending, Machine Practice, able to fix piecework prices for maximum output. Wednesbury district.—Address, 8562, The Engineer Office. 8562 A

## SITUATIONS WANTED

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**CONSTRUCTIONAL ENGINEERS.**
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# A Seven-Day Journal

## New P. and O. Liners.

AFTER undergoing a series of successful official trials in Belfast Lough on Thursday last the new P. and O. Liner Razmak was handed over to her owners by the builders, Harland and Wolff, Limited. The new liner has been designed especially for continuous service in Indian waters, and will run fortnightly between Bombay and Aden, at which latter port connection with the Australian service will be made. The Razmak is due to leave London on March 13th for her maiden voyage. She is a twin-screw vessel of 10,600 tons gross, with a length of 500ft., a breadth of 63ft., and a depth of 37ft. 3in., with a straight stem and an elliptical stern. Her propelling machinery consists of two sets of quadruple-expansion balanced engines, designed for an output of 12,000 indicated horse-power. Steam is generated at 215 lb. working pressure in four double-ended and two single-ended boilers. Howdens' forced draught system is fitted, and the boilers are furnished with Todd burners designed to use Persian oil fuel. A large number of the auxiliaries are electrically driven, and power is provided by three 150-kilowatt 220-volt generators, which are directly coupled to compound reciprocating steam engines. The passenger accommodation and public rooms are in keeping with the high standard which is maintained in the P. and O. Companys' ships. The Razmak will replace the 6000-ton steamship Salsette, which was sunk by a submarine during the war. Other liners at present under construction for the P. and O. Company on the Clyde and North-East Coast include the Cathay, Chitral and Comorin, 15,000-ton ships, for the Australian service, and the Rawalpindi, Rajputana Ranchi and Ranpura, 16,000-ton vessels, for the company's Bombay mail service.

## The De Vecchis Beet Sugar Process.

A WHITE Paper giving the Commission of Inquiry's Report on the De Vecchis Beet Sugar Process was issued by the Ministry of Agriculture on Monday. The Commission recommends that, having regard to the possibilities of a desiccating process in the development of the sugar beet industry in this country, a complete De Vecchis plant of small capacity, but on a factory scale, should be set up in England, with a view to testing the process experimentally. The proposed plant should incorporate improvements to secure efficient desiccation and defecation, and further experiments should be undertaken in order that a satisfactory form of cleaning, slicing and desiccating equipment, which would be capable of being used by the beet grower might be produced. In contrast with the ordinary diffusion process in which fresh beets are directly used in the factory over a limited period, a campaign of 90 days or so, the De Vecchis process provides for the slicing of the fresh beet into cossettes which are afterwards desiccated in a drying apparatus. These cossettes may be stored for several months without fear of damage, enabling the subsequent extraction of sugar from the dried cossettes to take place over 300 days in the year. The drying process reduces the moisture content of the fresh beet from 80 per cent. to about 3 per cent. When dried the cossettes have only 25 per cent. the weight of fresh beet, which fact effects a considerable saving in the transport charges. The grower, it is hoped, would be able to desiccate his own crop at a time convenient to harvest operations. The inventor also claims that less machinery and apparatus is needed for subsequent extraction by lixivation, with reduced capital charges. It is stated that less water is required than with the diffusion process, and that the quantities of sludge and effluents are smaller.

## Aircraft Carriers.

THE aircraft carrier is now recognised as an indispensable unit of every modern fleet, and vessels of this type are included in the building programmes of the leading naval Powers. According to a tabular statement furnished by the Admiralty, the British Navy enjoys a marked advantage over all others as regards aircraft carriers, of which it has six, with a total displacement of 112,300 tons. The United States has three ships, totalling 78,700 tons, while Japan has two ships of 27,000 tons each, besides a third vessel of 9500 tons in course of construction. Of the British carriers the oldest and slowest is the Argus, which has a speed of 20.2 knots. The Eagle, formerly a battleship, is good for 24 knots, and the Hermes for 25. These three vessels are already in commission. They will eventually be joined by the Furious, Courageous, and Glorious, all of which are capable of steaming at 31 knots. They were built during the war as light battle-cruisers, mounting the heaviest guns, but in their new *rôle* as aircraft transports they will probably prove much more useful. As reconstructed, the Furious is reported to have no funnel. It is interesting to note that the Admiralty statement gives the displacement of the Courageous and Glorious as 22,500 tons each, which is 3900 tons more than the displacement before reconstruction. The only American carrier in service is the Langley, a converted collier, which has the very low speed of 14½ knots. The other two ships of this class credited to the United States Navy are both former battle-cruisers, of 33,000 tons each, but their reconstruction will not be completed for two or three years. They are designed for 33½ knots, and each will mount eight 8in. guns.

## The Smallness of the Atom.

THE first lecture of the series on "The Counting of Atoms," delivered at the Royal Institution by Sir Ernest Rutherford, was devoted mainly to a survey of the growth of the atomic theory of matter from the time it was first conceived, over 2000 years ago, by Greek philosophers. During the last twenty years, Sir Ernest explained, and particularly since the discovery of radium and other similar substances, men of science had been busy inventing and developing methods of counting and weighing atoms, and their investigations had resulted in a complete experimental verification of the atomic theory. The investigations had disclosed both the enormous number and the incredible smallness of atoms in the smallest particle of matter. Something like 100,000,000 atoms could be placed side by side in the space of an inch. The lecturer gave the mathematical formulæ by which the size and mass of atoms have been determined, and pointed out that although different methods did not give precisely the same results, they were all in close agreement and thus corroborated each other.

## The Burney-Wallis Airship.

THE five million cubic foot airship which the Airship Guarantee Company is building under its special contract with the Air Ministry, will, it is announced, present considerable novelty in its design. That design has been evolved by the company to the Air Ministry's specification of general features, and to the requirements of the Aeronautical Research Committee. Its chief departure from current practice lies in the fact that the attainment of complete streamline form will be promoted by the elimination as far as possible of all external projections from the envelope body. To this end the passengers' saloons and the control and observation compartments will be arranged inside the hull, and not, as usual, be suspended outside it. It is not clear, however, whether the engine compartments are also to be inside the hull. The airship has been designed in conjunction with a new design of mooring mast. Instead of being anchored merely by a point at the nose, the airship will be attached to the mast by means of two arms capable of being swung horizontally about the top of the mast to meet the airship from whatever direction she may approach. The vessel will be rigidly anchored to the arms at two points on each side of the nose. This plan, it is claimed, increases the safety of the passengers entering or leaving the vessel, augments the strength of the structure at the nose, and permits that end to be devoted to the housing of the control and observation compartments. It is stated that American and German airship authorities have approved of the new type of mooring mast, and have agreed to accept it as a standard design.

## The Deptford Power Station.

AT the ordinary general meeting of the London Electric Supply Corporation, held a few days ago, it was stated that during the past year considerable progress was made in connection with the extensions at the Deptford power station and that no less than 80,000 horse-power is being added to the existing plant. A large part of this additional power will be utilised by the Southern Railway Company as soon as the various stages of its traction schemes are completed. It is hoped to give a supply at an early date to the already electrified portion of the Brighton line, and in July to provide the current necessary for working the South-Eastern portion of the Southern Railway. For the past sixteen years the London Electric Supply Corporation has provided the single-phase current used on the first electrified section of the Brighton system, and the additional supply will enable the Corporation to make efficient use of the capital it has recently expended and will tend to reduce the cost of production.

## Platinum in the Transvaal.

FROM a report to hand from Dr. Wagner, of the Union of South Africa Geological Survey, it would appear that the discovery of platinum in the Lydenburg district of the Transvaal is of an important nature. The deposits, we learn, have been found in a belt of country nearly 60 miles long, and are found under conditions very similar to those prevailing in the Urals and in Colombia. They occur on two "horizons," and are found partly as a primary constituent in basic rocks, and partly in alluvial deposits derived from the disintegration of these rocks. The main or upper horizon deposits would appear to be the more important. They are said to outcrop continuously for thousands of yards, and to assay up to 7½ dwt. per ton, with an average over considerable stretches of 2 dwt. to 3 dwt. The assays were, however, made from samples taken at the outcrop or immediately below it, and it has yet to be determined to what extent the platinum content found has been affected by mechanical surface enrichment, a phenomenon to which platinum, like gold and other heavy metals, is very susceptible. The only way to test whether there has been marked surface enrichment is, says Dr. Wagner, to sink a number of shafts to a depth of 20ft. or so. At the worst, however, he holds, certain of the stretches sampled should yield a fairly big tonnage of workable surface ore, while, if the values found on the surface extend only to the water level, the upper horizon should provide sufficient low-grade ore to make the district a platinum-producing area of the first importance.

## The Qualifications of Consulting Marine Engineers.

AT the annual meeting of the Society of Consulting Marine Engineers and Ship Surveyors, which was held in London last week, Mr. H. E. J. Camps, the newly elected President, referred in his address to the qualifications necessary for membership of the Society. During the past four years the position of the Society, he said, had been consolidated, but the position had now been reached when greater stringency in testing the qualifications of applicants for membership should be exercised. The advances which had been made and were still taking place in the science and technique of shipbuilding and marine engineering were such as to render it absolutely necessary that those who were invested with the duties of supervising the construction and running of vessels, and their maintenance and repair, should be men who possessed the soundest scientific and technical qualifications. He would certainly regard a sound education in the principles of naval architecture and marine engineering and a practical training in both branches as essential. Actual practical experience was most important, and was necessary to distinguish between good and bad workmanship, and to determine in what respect a particular piece of work might be defective or inefficient. Such judgment could only be acquired by one who had worked at the trades in question. Mr. Camps further expressed his desire that a committee should be appointed to consider an examination syllabus for future candidates.

## Parachutes for the Royal Air Force.

AFTER a long period of waiting and watching, the Royal Air Force is apparently at last to be equipped with parachutes for use in case of emergency. In the debate on the Air Estimates Sir Samuel Hoare announced that an order had been placed in the United States for a number of Irvine parachutes of the "free" type, and that the first deliveries were expected in about a fortnight's time. It has been stated unofficially that the order involves an expenditure of £150,000 in all, and that arrangements will probably be made for the manufacture of the Irvine parachute in this country. The "free" type of parachute is one in which there is no connection with the machine at any point. The pilot carries it on his body and is free to jump overboard with it when emergency arises. In the Irvine type the pilot, after dropping clear of the machine, pulls a cord which opens a flap and allows a small "pilot" parachute to shoot out under the action of a spring. The resistance created by this "pilot" parachute opens out the main parachute, which when in action allows the aviator to descend at a uniform speed of 6ft. to 10ft. per second. In the "fixed" type of parachute, of which several British examples exist, the aviator, when he jumps clear, pulls the apparatus out of its case which is attached to the machine. It is understood that exhaustive official tests of both types have been made and that the fixed pattern has been adjudged dangerous on the ground that it may fail to open properly or become entangled with the abandoned machine.

## A Steel House Constructors' Union.

A MOVEMENT which may go far to remove the existing restrictions imposed by the building unions on the construction and erection of steel houses was begun at a meeting at Leytonstone on Tuesday evening, when a resolution was carried pledging those present to form a steel house construction union. The meeting was convened by the Leyton and Leytonstone Unemployed Workers' League, and the chair was taken by Mr. E. Hayward. The League has formulated a trades union scheme which is now nearly complete, under which it hopes to guarantee trade union wages and regular employment to its members. The scheme, we understand, offers free instruction in the building of steel houses, extending over a few weeks, during which time the men would be paid a certain amount of money. At the end of the proposed period it was expected that the men so trained would be fully competent to build steel houses. An important feature of the proposal is the fact that the men so engaged will be taken out of their present hopeless condition of unemployment. In the general discussion of the plans we have outlined it was made clear that it was not the intention of the new union to break or hurt in any way the already existing building trades unions. At the present time, it was pointed out, there was a shortage of 40,000 bricklayers, and within 40 miles of London no less than nine brickworks were in the market, and yet there was a continual shortage of building materials.

# The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. X.*

PERIOD 1846–1849.

THE effect of the Gauge Commission on locomotive practice was extremely marked, in that engineers were stimulated to construct engines of much greater power, with the result that the years 1846–9 were remarkable not only for some very large locomotives, but also for bold and varied designs. Included in this period are the outside cylinder "Crampton" type engines, which, though they did not produce any lasting effect on British practice, nevertheless had great influence on continental locomotive design. Before dealing with them, the Great Western broad gauge developments will be considered.

*Gooch's Great Western Railway Broad Gauge Engines, 1846–9.*—In April, 1846, the first of the famous 8ft. single engines was built at Swindon. This was the "Great Western"—Fig. 57—built as a trial engine, which differed from the succeeding "Iron Duke" class in that it ran on six wheels only, and had a fire-box casing of the "Gothic" form. The engine was specially built in view of the impending renewal of the gauge controversy before Parliament. The cylinders were 18in. by 24in. Driving wheels, 8ft., carrying wheels 4ft. 6in. diameter. Wheel base, 16ft., equally divided. Heating surface of 278 2in. tubes, 1582 square feet; of fire-box, 151 square feet; total, 1733 square feet. Grate area, 22.6 square feet. Pressure, 100 lb. per square inch. In June, 1846, the "Great Western" was stated to have run with 100 tons from London to Swindon, 77¼ miles, in 78 minutes, and the same month worked through to Exeter and back, the 194 miles each way being covered in 208 and 211 minutes' running time. The leading axle subsequently broke, after which the engine was altered and provided with two pairs of leading wheels, as in the later engines

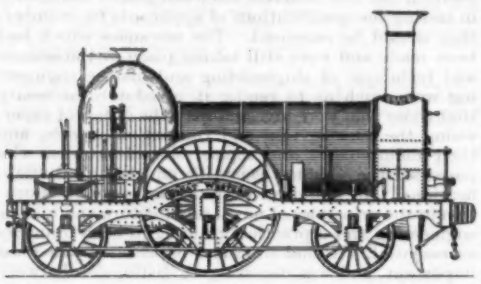


FIG. 57—GOOCH'S "GREAT WESTERN," 1846

The following class was less ambitious, and consisted of six engines, built in 1846–7, with 16in. by 24in. cylinders and 7ft. driving wheels—one engine with 7ft. 6in. wheels. They were characterised by inside frames only, which were of the sandwich type. The total heating surface was 1082 square feet, and the weight in working order 26 tons 2¼ cwt.

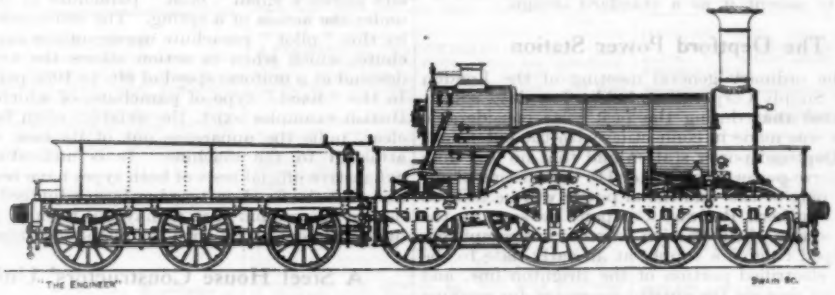


FIG. 58 GREAT WESTERN ENGINE "IRON DUKE," 1847

The "Great Western" having proved very successful, twenty-two additional engines of an improved type were built at Swindon in 1847–1851—Fig. 58. They had the ordinary form of raised fire-box casing, and ran on eight wheels, the drivers being 8ft., and the carrying wheels 4ft. 6in. diameter. As originally made the driving wheels had no flanges. The total wheel base was 18ft. 6in. The cylinders, 18in. by 24in., placed at 4ft. 2½in. centres, were completely enclosed in and jacketed by the lower part of the smoke-box. In addition to the outside sandwich frames, there were inside plate frames between the back of the cylinders and the front of the fire-box casing, as well as a fifth frame or "centre stay" of the same length along the centre line of the engine. Each of the five frames had a bearing for the driving axle, but the carrying axles had bearings in the outside frames only. The slide valves were partially balanced by means of pistons in the common steam chest. The pistons worked inside a small cylinder open at the ends, and were coupled by links to the backs of the valves. The principal objections to this method were the rattling noise, the danger of the link pins coming out and getting into the cylinders, and the wear of the balance piston rings, which caused leakage and consequent loss of the balancing effect. Subsequently ordinary unbalanced slide valves were substituted. The boiler barrel was 4ft. 9½in. diameter outside the largest ring, and pitched 7ft. 2in. centre above rails. There were 303 2in. tubes, which in the first six engines—"Iron Duke" class—provided 1647.4 square feet of heating surface, to which the fire-box, with transverse partition added 142.8 square feet; total, 1790.2 square feet. Grate, 21.6 square feet. Pressure originally 100 lb., afterwards increased to 120 lb. The later sixteen engines—"Courier" class—had shorter tubes and a longer fire-box. The hearing surface of the latter was 156.5 square feet, and the total 1767 square feet. Grate, 25½ square feet. The weights in working order varied from 35½ tons with 12 tons 6 cwt. on the driving wheels in the earlier engines to 38¼ tons with 14 tons on the drivers in the later engines. All were fitted with Gooch's stationary link motion.

The boilers were domeless, and steam was taken from a perforated pipe—Hawthorn's 1839 patent—which terminated at a regulator box in the smoke-box. The regulator was of the slide valve type with pull out handle. The wheels, including the 8ft. drivers, were of wrought iron forged solid with the bosses. The revolving masses were balanced by weights in the rims of the driving wheels. A single inverted spring on each side carried the weight on the two leading axles.

Seven more engines of this class were built in 1854–5 by Rothwell and Co., making a total, including the Great Western, of thirty. Although most of the original engines were broken up between 1870 and 1880, they were replaced by new engines almost exactly similar but with 140 lb. pressure. In the later engines cabs were also provided, and the total weight was increased to about 41½ tons, of which 16 tons rested on the driving wheels.

Twenty-three were at work on the fastest main line trains in May, 1892, when the broad gauge ceased to exist. When they were new they were ahead of the times, but in their later years, as train loads increased, the lack of adhesive weight told badly against them. Further particulars will be found in THE ENGINEER, June 16th, 1882, page 429.

The broad gauge 0–6–0 goods engines of 1847, though large machines, had a tractive force considerably lower than that of some of their standard gauge contemporaries, but they excelled the latter in boiler power. Their principal claim to interest lies in the position of the trailing axle behind the fire-box, coupled with the use of inside—sandwich—frames. The wheels were 5ft. diameter, cylinders 16in. by 24in., and heating surface 1363 square feet. Weight in working order, 27¾ tons.

The 4–4–0 saddle tank engines—Fig. 59—built in 1849, were amongst the most interesting of Gooch's designs. The type of bogie, which with minor modifications was in use until May, 1892, swivelled on a ball and socket joint, the socket being connected diagonally with the horn plates by four strong forgings, 5in. deep by 1¼in. thick—Fig. 60. The pivot or ball was riveted into a double gusset, which in turn was riveted to the bottom of the boiler and the steam chest. A single inverted spring transmitted the load to the two axle-boxes on each side. As equalising levers were provided between the coupled wheels, the spring-borne weight was carried on three points, and the engines were the first in this country, except Carmichael's Dundee and Newtyle engines—Fig. 21, *ante*—and the Norris engines, in which this method of spring suspension was used. The main inside sandwich frames were rigidly fastened to the boiler by strong brackets, and extended from these, which were situated at the front of the driving wheels, to the back buffer beam. The force between the cylinders and driving axle was, therefore, transmitted through the boiler, except for the intervention of a single centre stay from the back of the cylinders to the front of the fire-box casing. The front buffer beam was connected to the cylinder sides by plates. The whole arrangement was radically defective, and the first twenty-one engines of the type were scrapped as soon as their original boilers were worn out. Similar engines on the South Devon railways from about 1866 had plate frames from front to back.

The cylinders were 17in. by 24in., coupled wheels of the first two engines built at Swindon in 1849, 6ft., and of thirteen built by R. W. Hawthorn in 1854, 5ft. 9in. The bogie wheel base was 5ft. only. The bogie had a swivelling movement without lateral play, and there was no arrangement to prevent cornering except the top of the front axle guard, which ultimately came into contact with the smoke-box casing surrounding the cylinders. In all Gooch's bogie engines the bogies were set well back to reduce the total wheel base, which in the above engines was 18ft. 2in. The driving tires were flangeless. These engines had sledge brakes bearing on the rails between the coupled wheels. These were a constant source of trouble, not only damaging the rails, but frequently getting on the wrong side of crossings. When in action, they lifted the back end of the engine on the springs, in some cases reducing the weight on the coupled wheels to a dangerous extent. The iron tires had steel faces.

*Outside Cylinder Crampton Locomotives.*—The Crampton locomotive was another attempt to obtain a large heating surface combined with a low centre of gravity. The patentee, Thomas Russell Crampton, held the opinion that a steady engine would result if the centre of gravity was situated as nearly as possible on the same horizontal line as the draw-bar. This was true so far as the vertical "pitching" movement was concerned, especially as he made a point of avoiding overhanging masses at each end, and of distributing the weight so that the greater part was carried by the leading and the trailing (driving) wheels, with comparatively little on the middle carrying wheels. As the driving wheels were placed at the rear, behind the fire-box, the cylinders were brought back to a position near the middle of the engine, between the two front carrying axles, and lateral swaying was thereby reduced.

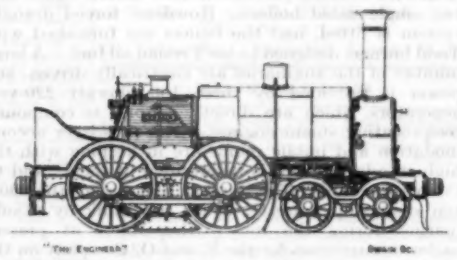


FIG. 59 SADDLE TANK ENGINE, 1849

Moreover, Crampton was probably the first locomotive engineer to point out that the hind axle of an engine passing round a curve does not move towards, but away from, the outer rail. This fact, which has an important bearing upon the wear of tires, has long been recognised by continental locomotive engineers, but appears to have been accepted in this country only of recent years. But for this, the flange wear of the large rear driving wheels of Crampton's engines would have been excessive.

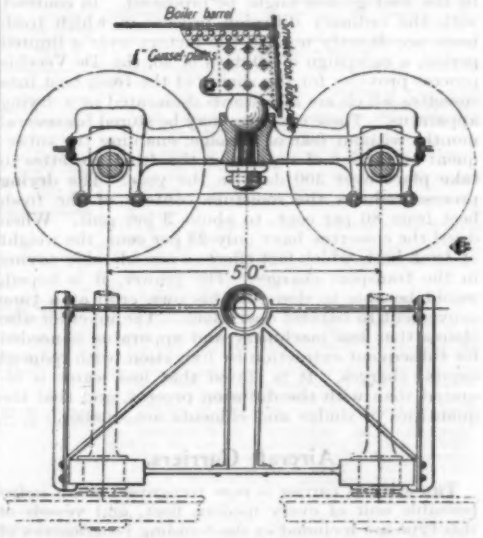



FIG. 60—GOOCH'S BOGIE, 1849

Crampton's first patent of February, 1842 (not 1843, as given by D. K. Clark), combined two claims. In the first the boiler was slung under the driving axle of a six-wheeled engine, but no engine of this type was built until Francis Trevithick produced the Cornwall at Crewe in 1847. In the second claim a four-wheeled engine was proposed, in which the driving axle was placed behind the fire-box. But actually when the first engines were built in 1846 it was found necessary to have six wheels, and therefore two pairs of front carrying wheels were used.

The date of the patent shows that Crampton was

* No. IX. appeared February 27th.

not attempting to improve upon Stephenson's long boiler design by making a steadier engine, since only two or three long boiler engines of the inside cylinder type had then been at work a few weeks. It is open to question whether the position of the driving wheels behind the fire-box was really patentable, since Stephenson and Tayleur had built such engines for America in 1833—see Fig. 19 *ante*. Crampton stated that he did not know this until many years later, and it does not appear that R. Stephenson or others ever questioned the validity of the patent.

Most of Crampton's engines had large 7ft. driving wheels, and in two they were as large as 8ft. for the reason that tire wear was thereby reduced. The length of turntables did not trouble Crampton, as it had affected Stephenson when designing the long boiler engines. Crampton's earliest engines had a total base of 13ft. to 14ft., and in the eight-wheeled Liverpool it was 18ft. 6in.

Features of the design included a driving axle which was situated above the footplate just below the fire door and enclosed within a casing. The driving horns were inverted, and placed above instead of below the main frames. The driving springs had very long spring pillars, which raised them level with the tops of the driving wheels, and the front hanger was attached to the fire-box shell. Alternatively, a single transverse spring was used, which was carried across the footplate immediately in front of the driver. Many of the boilers were elliptical with flattened sides, stayed across. The whole of the motion and valve gear were outside.

The first two engines were built by Tulk and Ley, of Whitehaven, in 1846, for the Namur and Liége Railway—then a British-owned company. They had 7ft. solid wrought iron wheels and 16in. by 20in. cylinders. The total heating surface on the fire side was 989 square feet, and the grate area 14½ square feet. In these and most of the succeeding engines the fire-box was extremely short at the top, being only about 2ft. long for the depth of the tube plate; below the latter it was splayed out both at the front and back to a length of 5ft. to 6ft. An exactly similar engine was built in 1848 by Tulk and Ley for the Dundee and Perth Railway. This type is shown in Fig. 61.[1]

One of the Namur engines was tested before export on the Grand Junction Railway, with the result that the L. and N.W.R. decided to try "Cramptons." The first of them was the Courier, which was built at Crewe works in November, 1847, under Allan's supervision,[2] from general drawings supplied by Crampton, though some of the details show the Crewe practice of that period, including an outside frame stay between the cylinders and the trailing buffer plate. The fire-box was raised 1ft. 9in. above the barrel to provide room for a second pipe, from which steam could be taken, in addition to the pipe in the dome. This was necessary since the oval boiler was packed with 196 1⅞in. tubes, which left too small a steam space. The boiler centre was only 4ft. 7in. above rail level. The steam chest was above the cylinders, and the valves were worked by rocking shafts and Gooch's link motion, the only instance of the use of this gear in a Crewe-built engine. In most respects the Courier was totally different in detail from all other "Cramptons." The driving wheels were 7ft. and the cylinders 16in. by 20in.; pressure, 90 lb. This engine is shown in Fig. 63.

For the southern division of the L. and N.W.R. a larger six-wheeled engine, with 8ft. driving wheels and 18in. by 20in. cylinders, was built by Tulk and Ley in 1847. The oval boiler had a diameter of 4ft. 8in. vertically and 3ft. 10in. horizontally, and was stayed transversely throughout its length. The total heating surface was 1529 square feet. Grate area, 16 square feet; pressure, 100 lb. The tires were of Bowling iron, purchased in 12ft. and 25ft. 6in. lengths and afterwards welded up. The weight in working order was a good example of the distribution at which Crampton aimed. Of the total of 25 tons 12 cwt., when loaded, 11 tons 14 cwt. rested on the rear drivers, and 8 tons 3 cwt. on the front carrying wheels, leaving only 5 tons 15 cwt. on the middle wheels. Complete drawings of this engine, the London, were published in THE ENGINEER, November 28th, 1890.

All the above engines, as well as a number on the South-Eastern Railway,[3] had inside frames and bearings only for all axles. In this respect they differed from Crampton's later designs of 1848, in which there were two frame plates on each side, between which the cylinders were fastened. The carrying wheels had bearings in the outside frames only, but the driving bearings were inside. In these engines the boiler was independent of the framing, upon which it rested by means of brackets, a great improvement upon the usual method of rigid connection. The frames were strongly braced by transverse plates. Another excellent feature was long bearings, those of the driving axles being 12in., and of the carrying axles 10in. long. The wheels were of wrought iron throughout.

The boilers were domeless, steam being taken from an internal pipe with a slit along the top and a short T pipe branching upwards near the middle. This T pipe entered a small square box which contained the double slide valve regulator, moved longitudinally by an external rod. The steam pipes to the cylinders branched out on each side of the box and were carried externally down to the cylinders which lay immediately below. This was the well-known Crampton regulator, used extensively for many years in France and Germany, but only on a few Crampton engines in this country.

Of the above "mixed framed" engines E. B. Wilson and Co. built five in 1848 for the Eastern Counties Railway, with 16in. by 20in. cylinders and 7ft. driving wheels. The leading wheels were 4ft. 6in., but the middle wheels were 3ft. 6in. diameter in order to clear the cylinders. The total wheel base was 15ft. 3in. These were the forerunners of the celebrated French "Cramptons" on the Nord and other railways, which were of very similar design, though of somewhat different dimensions, and had flush fire-box casings. Boilers of this latter design have always been known in France as "chaudières Crampton."

The large eight-wheeled engine Liverpool—Fig. 62—for the L. and N.W.R. (Southern Division) was built by Bury, Curtis and Kennedy in 1848, and shown in the 1851 Exhibition. It also had mixed framing, both inside and outside plates extending throughout from front to back buffer beams. The two front carrying axles had one inverted spring on each side, as in Gooch's 8ft. engines, but all the carrying axle springs were underhung. Unlike the Eastern Counties Railway "Cramptons" which had Gooch's gear, the Liverpool had Stephenson's link motion. In the early "Cramptons" the excentrics were of small size and fixed on return cranks as in Fig. 61, but in the Liverpool huge excentrics, the sheaves of which were about 2ft. 9in. in diameter, were fixed to the driving wheel bosses, with the object of avoiding overhung return cranks. This form of excentric was patented by Crampton in June, 1847, and was first used on the Cornwall and Velocipede, built at Crewe, but was soon abandoned owing to the enormous friction and consequent heating. The fire-box of the Liverpool had a longitudinal midfeather with two grates and two fire-hole doors.

The driving wheels were 8ft. diameter and the cylinders 18in. by 24in. The total (rigid) wheel base was 18ft. 6in. The boiler, the centre of which was only 5ft. 3in. above rail level, was oval and contained 292 2³/₁₆in. tubes, the heating surface of which was 2136 square feet; total heating surface, 2290 square feet; grate area, 21.5 square feet; pressure, 120 lb.; weight in working order, about 35 tons.

The Liverpool worked heavy trains between London and Wolverton, but can hardly be considered otherwise than as a daring freak. It damaged the road

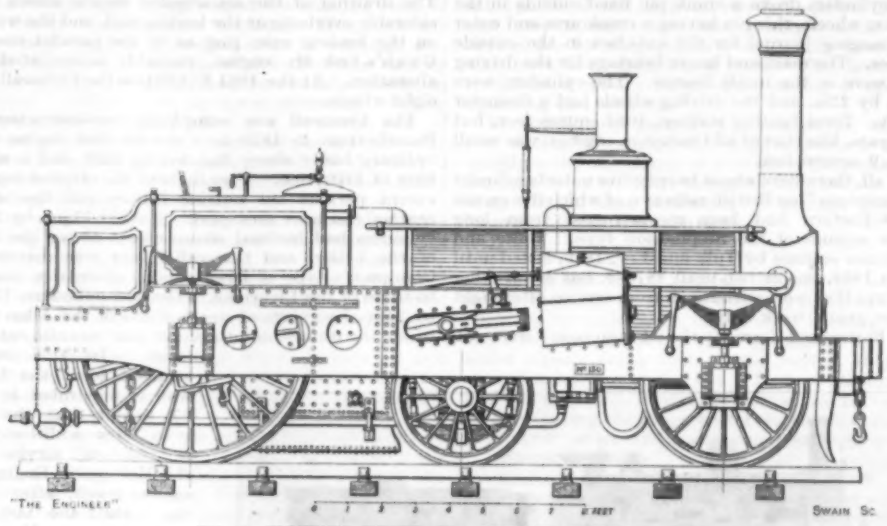



FIG. 64—CRAMPTON ENGINE FOR MIDLAND RAILWAY, 1848

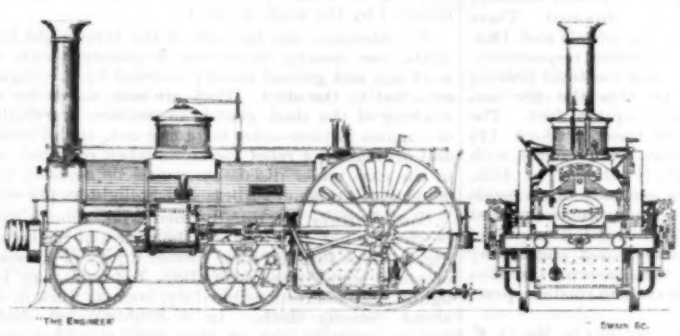



FIG. 61—CRAMPTON ENGINE, 1848

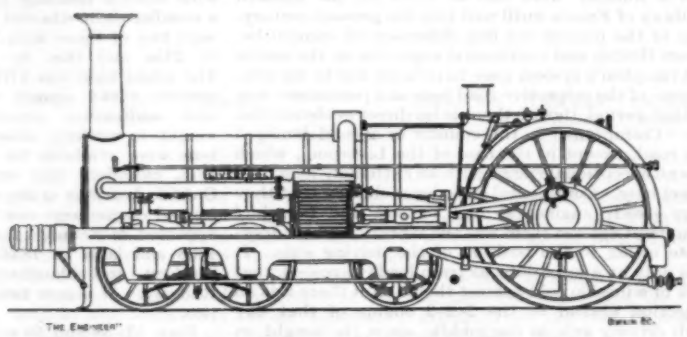



FIG. 62—CRAMPTON ENGINE, L. AND N.W. RAILWAY, 1848

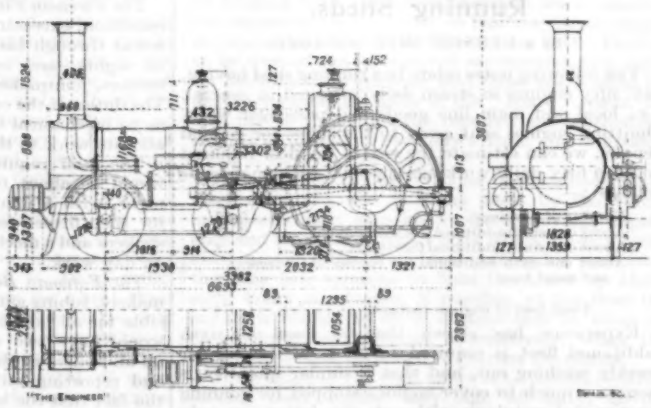



FIG. 63—CRAMPTON ENGINE, L. AND N.W. RAILWAY, 1847

[1] Figs. 61 and 63 have been reproduced from "Die Crampton Lokomotive," by F. Gaiser. Neustadt a.d. Haard, 1909, the only book which gives a full account of Crampton's engines.

[2] Letter from Alex. Allan, quoted in THE ENGINEER, May 28th, 1883, p. 405.

[3] Illustrations and particulars of several of the South-Eastern "Cramptons" may be found in an article by Mr. A. Rosling Bennett in THE ENGINEER, July 1st, 1910.

badly, perhaps less on account of its weight than of its long rigid wheel base.

A unique design of Crampton engine is shown in Fig. 64. Two engines of the kind were built in 1848 by Kitson, Thompson and Hewitson for the Midland Railway. The speciality lay in the deep double frame, which had outside bearings for the leading and trailing (driving) axles, but the middle axle had inside bearings only. The connecting-rods of the outside cylinders drove a crank pin fixed outside in the driving wheels, this pin having a crank arm and outer overhanging journal for the axle-box in the outside frames. The main and larger bearings for the driving axle were in the inside frames. The cylinders were 16in. by 22in. and the driving wheels had a diameter of 7ft. Total heating surface, 1062 square feet, but the grate, like that of all Crampton engines, was small —13.9 square feet.

In all, there were about twenty-five outside cylinder "Cramptons" on British railways, of which five on the South-Eastern had been reconstructed from long boiler engines of the Stephenson type. These and three new engines by Tulk and Ley, 1849, lasted until about 1865, one or two until 1874–5, but on all other railways they were withdrawn from service after eight to ten years' work only.

In France and Germany the "Cramptons" were well liked and nearly 300 were constructed up to 1864. Moreover, they remained in service much longer, and a number were still at work on the Eastern Railway of France until well into the present century. One of the reasons for this difference of opinion between British and continental engineers on the merits of Crampton's system may have been due to the conditions of the respective road beds and permanent way of that period, though there is no direct evidence that the "Cramptons" in this country or abroad damaged the road, except in the case of the Liverpool, which was an exceptional engine with an extremely long rigid wheel base. Continental experience showed that they were steady engines at high speeds, and the chief complaint against them was the vibration on the footplate owing to the position of the driving axle. It was only at a later date, as train loads increased, that lack of adhesion told against them. But there was an objection abroad to the 2–2–2 engine of that day with driving axle in the middle, since the weight on this axle in many cases was 50 per cent. or more of the total, and the leading axle was too lightly loaded. On an uneven road bed there resulted a vertical "pitching" movement about the driving axle, and the already lightly loaded leading axle was periodically relieved of part of its weight. In the "Cramptons" the leading axle was comparatively heavily, and the middle axle lightly loaded, with the result that very little "pitching" took place, more especially since the upward thrust on the slide bars was in the same transverse plane as the centre of gravity of the engine. The mid-position of the cylinders, and the longer wheel base considerably reduced the swaying.

The defect of Crampton's system was the small proportion of adhesive to total weight, owing to the distance of the driving axle from the centre of gravity, and this defect would have been still more serious but for the heavy non-spring-borne weight of the large driving wheels. On many of the continental engines a weight had to be added at the footplate end. On the other hand, the adhesion of the rear driving wheels on moderate curves is greater, since the trailing axle tended to run radially.

The "Cramptons" were fast runners. D. K. Clark mentions that the L.N.W.R. 8ft. engine London took a train of eleven coaches—55 tons—at 53.4 miles per hour in one run of 30 miles. In the trials on the P.L.M. Rly. after the Paris Exhibition of 1889 the highest speed of all the engines tested, 89.5 miles per hour, was attained by a single driver Crampton with a load of 157½ tons. This engine had the reciprocating masses balanced, which was not the case in the early engines in this country.

*Other Express Engines of Special Types.*—Three of these merit special mention. One was the L. and N.W.R. Cornwall, built at Crewe in November, 1847, to Mr. Francis Trevithick's design. To obtain a low centre of gravity the boiler was made of an extremely complicated shape and placed below the driving axle. The arrangement is shown in section in Colburn's "Locomotive Engineering," page 71. The driving wheels were 8ft. 6in. diameter. The driving axle passed through a channel recessed in the top of the boiler, and the trailing axle through a transverse tube through the fire-box. The underhung boiler formed part of Crampton's patent of 1842.

A few years ago original drawings of the Cornwall were published[1] showing the engine on six wheels only, with a wheel base of 12ft. 11in., and both carrying wheels 4ft. diameter. It is possible that it was actually built in this form, and was shortly afterwards converted to the eight-wheeled type, as illustrated in Colburn, with two pairs of leading wheels 3ft. 6in. diameter, and a total wheel base of 16ft. 6in. The drawing of the six-wheeled engine shows considerable overhang at the leading end, and the weight on the leading axle, just as in the parallel case of Gooch's first 8ft. engine, probably necessitated the alteration. At the 1851 Exhibition the Cornwall had eight wheels.

The Cornwall was completely reconstructed by Ramsbottom in 1858 as a six-wheeled engine with ordinary boiler above the driving axle, and a wheel base of 14ft. 10in. Very little of the original engine, except part of the outside frames and the wheel centres, can have remained. The old 17½in. by 24in. cylinders had inclined steam chests above the level of the boiler, and the valve gear was driven by Crampton's type of large outside excentrics, similar to those of the Liverpool. The new cylinders, 17½in. by 24in., had vertical steam chests of the Allan type inside the frames, and the valve gear was also entirely inside. In this reconstructed form the Cornwall is illustrated in Fig. 65, except that the cab is a later addition. It is still in service on the Mechanical Engineer's saloon coach, after having worked the fast expresses between Manchester and Liverpool until 1902, when it was withdrawn from regular train service.

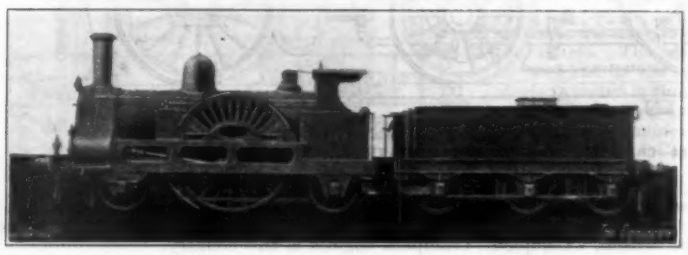


FIG. 65—THE "CORNWALL," L. AND N.W. RAILWAY, REBUILT 1858

Another type of L. and N.W.R. express engine by Stephenson, 1848–9, was directly derived from the long boiler engine with rear driving wheels by the addition of a small pair of carrying wheels with outside bearings behind the fire-box, whereby a steadier eight-wheeled engine was obtained. There were two of these with 7ft. driving wheels and 18in. by 21in. and 16in. by 24in. cylinders respectively. The wheel base was 17ft. 6in., and the total heating surface 1386½ square feet. Of this the fire-box, with midfeather, provided 91½ square feet. The weight in working order was 30 tons, of which 12½ tons were available for adhesion. The engine with 18in. cylinders was subsequently altered to 16in. Outside bearings *at the trailing end only* of an inside framed engine were not new. The arrangement first appeared in Rennie's London and Croydon engine of 1838 and later in 1846 in some 2–2–2 engines by Stothert and Slaughter for the Eastern Counties Railway. It is now frequently used in modern practice.

Figs. 57, 58 and 59 are from drawings by Mr. G. F. Bird, originally published in the *Locomotive Magazine*, and Fig. 60 from a book by the writer, is added by permission of the Locomotive Publishing Company, Limited. Further particulars and drawings of the Midland Crampton engine—Fig. 64—were given by Mr. E. A. Forward, M.I. Mech. E., in the *Locomotive* of August 15th, 1922.

## The General Organisation of Running Sheds.

By a RUNNING SHED MANAGER.

The following notes relate to a running shed having, say, fifty engines in steam daily, engaged in general, *i.e.*, local and main line goods and passenger work. Omitting engines sent away to the shops for general repairs, we can estimate the size of the fleet required to keep fifty daily workings supplied with engines as follows :—

| | |
|---|---|
| Number of workings .. .. .. .. .. .. .. | 50 |
| About one-sixth additional for washing-out .. .. | 8 |
| About one-sixth additional for repairs .. .. .. | 8 |
| About one-sixth additional for special odd duties and stand-byes .. .. .. .. .. .. .. .. | 8 |
| Total fleet of engines required .. .. .. | 74 |

Experience has shown that at least one-sixth additional fleet is required to allow of the regular weekly washing out, and that a similar quantity is none too much to cover engines stopped for running repairs and re-tubing, although this latter can only be an average figure depending on the stress of the work done, the greater the stress the greater the margin required.

The subject may be considered under three headings—(1) Organisation ; (2) Operation ; (3) Repairs.

### (1) Organisation.

The accompanying diagram shows a suitable organisation of staff in "tree" form. It begins with the chief foreman, sometimes known as the shed manager, who is personally responsible to the divisional locomotive superintendent or divisional superintendent of operation, according to the main organisation of the particular railway.

The main duties of the chief foreman, apart from general supervision are (*a*) charge of his breakdown gang in the case of accidents which block the main line ; (*b*) discipline, *i.e.*, the punishment of all defaulters, except for any offences that may involve dismissal or reduction in grade, which are usually referred to the divisional superintendent ; (*c*) daily perusal of the drivers' report books ; and (*d*) inquiry into all major irregularities of working, whether shown in the book or reported from outside, the lesser cases being usually delegated to the inspectors or clerks in order of importance.

A daily conference with the foreman fitter and boilermaker is advisable, as, if the work be not watched, it sometimes happens that the boiler repairs are finished before the fitting repairs are begun, and, *vice versâ*, causing unnecessary delay to the completion of any particular engine.

The chief foreman's principal assistant can be a locomotive inspector, who is generally recruited either from among the engine drivers or specially selected from ex-apprentices and pupils who have passed through the shops and drawing-office. He is usually charged with the duties of observation of the running condition of the engines belonging to his shed ; observation of the way in which the drivers and firemen perform their duties ; dealing with reports requiring investigation of signal-box records ; and examination of staff outside his shed ; assisting the duty list inspector to pass cleaners and firemen for promotion ; and supervision of small sheds that are attached for this purpose to the main shed, where such exist. In some cases, when the foreman is away on leave or sick, the inspector will assume control, but in other cases a relief foreman is supplied from headquarters.

Coming to the sections shown on the diagram, the clerical staff is in charge of a chief clerk, responsible for all correspondence and clerical matters, and his staff usually consists of an engine mileage clerk, a coal clerk, a mechanical staff wages clerk, a running staff wages clerk, a correspondence clerk, and an office boy or two, the duties being allocated as set out, but in actual practice one helps the other as required by the work in hand.

*The Shedmen*, one for each of the three eight-hour shifts, are usually ex-drivers acquainted with the workings and ground usually covered by the engines attached to the shed. They are responsible for the working of the shed, coaling of engines, marshalling of engines in time-order for going out, steam raising and arranging of relief for crews when required, and in the case under discussion would be assisted by a couple each of shed turners and firelighters per shift.

*Shed Turners* are usually men who, though competent, are not able to stand the racket of road working, perhaps through some former injury or ill-health or some slight eyesight failing, but who can face lighter and less responsible duty, such as work in and about running sheds. In a double-ended shed—*i.e.*, one that is open at each end—steaming about fifty engines daily, probably two shed turners per shift would be necessary in order to have the engines marshalled in going-out order, and those engines stopped for washing out and repairs knocked out and placed in the correct roads for the washers-out or repairing staff to deal with. The number of shed turners required per shift depends largely upon the arrangement of the shed, for instance, centre-turntable sheds require the minimum amount of engine arrangement, and, consequently, the minimum amount of shed turning, while deep single-ended sheds are very troublesome to arrange.

*The Foreman Fitter* is responsible for the mechanical condition, excepting boilers, of the fleet. He usually works through his examiners—one on days and one on nights—and controls all fitters and mechanical turners, jointmakers and smiths, and their assistants. The duties of the examiners are to examine all engines as to mechanical condition before going out, and to allocate work to the various men as required.

The staff required under the conditions set out would be about four fitters per day and three per night, with a jointmaker for each shift and a mate for each fitter ; together with two smiths and their strikers and a mechanical turner, the latter men being on day work.

*The Foreman Boilermaker* has charge of all boilermakers, tubing gangs, and washers-out, and is responsible for all boilers. He also, in a fifty-engine shed, would have two examiners to examine and report on all boilers in the shed monthly, as well as making and reporting on casual examinations. Owing to the fact that the boilers are usually too hot for handling after the day's work, but little boiler repairs can be effected by night ; consequently, saving for one examiner and one boilermaker—for casual tube expanding—on nights, practically all boiler work is done by day. Washing-out is also carried out by day, to avoid the danger of scalding occurring in the darkness. For expedition's sake, tubing gangs are best worked in shifts. The amount of retubing that has to be done varies with the quality of water used and the work done. An average requirement is met by four tubers in two shifts. Four boilermakers and four gangs of washers-out—three per gang—would com-

[1] The *Railway Gazette*, July 5th, 1918.

plete the boiler staff. It takes a gang approximately two hours to wash out a boiler thoroughly by the cold water method, and to sweep its tubes.

*The Foreman Cleaners*, one each for nights and days, are responsible for the cleanliness of the engines and the behaviour of the cleaners, and for the oil and waste storekeepers, of which there would be one to each eight-hour shift, each assisted by a lad. If the engines are to be kept clean, it will require at least three cleaners to two large engines or one cleaner per small engine, provided that they come into the shed daily.

*The Duty List Inspector* is responsible for the preparation of the daily turns of duty list, and also for passing cleaners and firemen for promotion and all eyesight tests, in which latter duties he would be frequently assisted by the outside inspector, as mentioned. He is always recruited from the drivers, and must have a knowledge of the duties and ground covered by his driving staff. He ought to have a clerk on each shift to take down drivers' reports and to witness signatures of all enginemen coming on duty. He requires an office boy as messenger and other boys to act as call boys.

### (2) Operation.

The lay-out of a good double-ended running shed can best be as follows :—The in-going siding should be in direct connection with both up and down main lines, trailing points being sufficient. This in-going siding should lead immediately on to the turntable, which should lead on again to an inwards road, provided with long pits to facilitate examination of engines, together with plenty of ground room each side for the piling up of the thrown-out fires. It is better still to have a parallel road sunk deep enough arranged along or across it, on which the numerous notices, workings and duty lists can be attached. In an ante room to this room should be the duty list inspector's office, with a shutter in the wall which can be opened by anyone in the signing-on room desirous of speaking to the inspector. A desk in some convenient place in the room is required for the clerk witnessing signatures—one of these to each shift. A swivelling rest for the signatures book will allow of the book being turned towards the clerk or the person signing on, as required. This clerk will also enter reports of irregularities in working, &c., from enginemen in a book—which should be read by the chief foreman daily—and he can also check the drivers' "tickets" in his spare moments. A telegraph and a telephone office is a necessity, and, of course, it must also be continuously manned. In some cases, during the slack periods of the day, it may be quite possible to amalgamate the two duties of telegraph and witness clerk.

The witness clerk is usually held responsible for the sending out of call-boys to call the enginemen for duty during specified hours of the night and early morning, and also to advise them of any "specials" and last-moment alterations at any time. If the men live at some distance it is economical to provide these call-boys with bicycles.

Other necessary buildings would include oil and mechanics' store rooms and three mess-rooms for enginemen, mechanics and cleaners respectively, and a mechanics' shop.

We will now follow an engine through from its coming on the shed to its leaving. On arrival in the in-going siding the turntableman will instruct the crew as to the turning of their engine for the next duty, and will also book their arrival time and their engine number for time-keeping purposes. If the remaining time on duty allows, the road crew will put their own engine away; but nowadays it is usual for "disposal and preparation" crews to relieve the roadmen on arrival at the shed or the station and to carry on in their stead. The engine having passed the turntable, the fire-box, ashpan and smoke-box are emptied of all fire and residue by the fireman, the driver meanwhile examining his engine all round. That being done, the engine is then coaled and moved on to the inwards fan of the shed itself, where the crew leaves it, and the shed turners take charge. By this time the steam has got pretty low; consequently, shed turners always work with their own shunting engines, moving the other engines about "dead."

The shed turner works from a list which he makes out daily when coming on duty, which shows him the time every engine is required to be in steam and the numbers of the engines to be laid off for repairs or washing out. His duties therefore are to marshal the engines as they come in, so that they are arranged in time-order with the earliest one out first. Engines to be washed out or repaired are shunted into roads set aside for that purpose, and those not booked for any purpose are set aside in the "spare" roads. He also has to shunt out the repaired and washed-out engines at the end of each day's work, and to arrange them in their correct places.

Before going out, each engine is examined by the fitter examiner, and in many cases by the boiler-maker examiner, who knows from previous experience and the drivers' repair book which fire-box needs examination. The firelighter, getting his time from the duty list, arranges to light the boiler up about eight hours in advance, if possible, of the time the engine is booked to be in steam—that is, when its crew comes on duty—or, alternatively, when the preparation crew is booked to prepare the engine.

The routine of the road crews is as follows :—After leaving their engine, they sign off duty, having entered any repairs required to the engine in the repairs book and reported any irregular working to the witness clerk, the report always being signed by the man reporting. The driver's ticket, giving a full account of his day's work, mileage run, stores consumed, has then to be handed in. The crew will then examine the duty list to find out their next time of duty and then go home. Coming on duty, they first sign the appearance book, the witnessing clerk handing them, and getting their signature for, any notice that is to be distributed. If the road crew are to prepare their own engine, the driver will get on with his examination and oiling, while the fireman obtains the stores and attends to the fire, &c. If the engine is got ready for them, they merely step on to the footplate and relieve the preparation crew. In any case, the shedman will give them the number of their engine and tell them where it is to be found. As the shedman is personally responsible for the engine leaving the shed to time, he naturally supervises the work of the firelighters, shed turners, turntable and coal men, and also the duties of the disposal and preparation crews, and arranges relief when applied for by telegraph or telephone by road crews who have been delayed *en route*. This latter is a complicated matter in the case of fog or accident upsetting the working.

The breakdown gang is drawn from the ranks of the mechanics' mates and shed labourers, and is usually under the charge of whichever fitter examiner happens to be on duty, except in very serious cases, when the foreman mechanic, or perhaps the shed foreman himself will take charge.

### (3) Repairs.

The old idea that "general" repairs, by which is meant thorough overhauls down to bolts and nuts, ought to be undertaken in the chief running sheds, only engines requiring new cylinders or heavy boiler repairs being sent to the central shops for attention, has almost died out. To-day running sheds find enough work confining themselves to running repairs, leaving the shops to tackle the heavier jobs with their better and more numerous appliances.

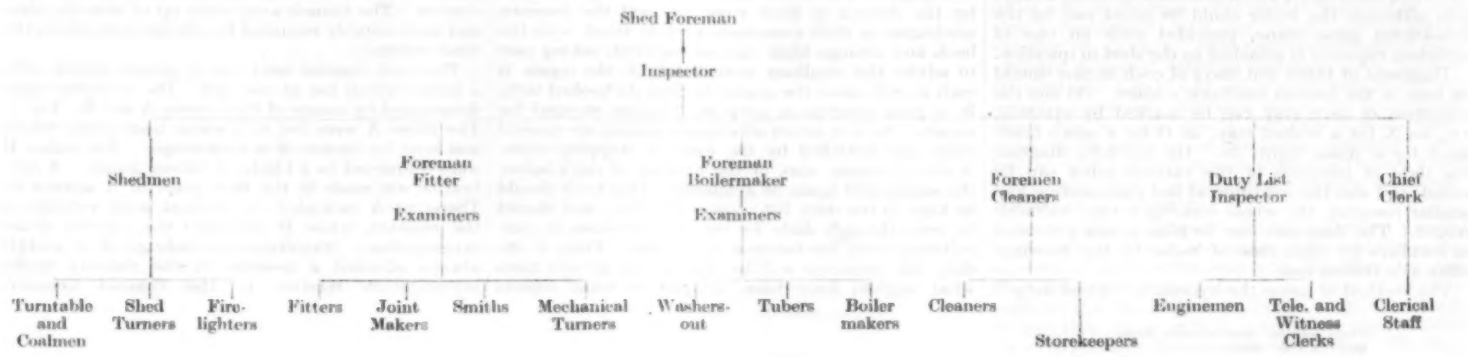
"Running repairs" can be said to include re-tubing boilers, renewing stays here and there, facing up ports and slide valves, machining and refitting big end brasses, adjusting excentrics, attending to hot axle-boxes, and similar detached jobs; while a "general repair" implies a complete stripping down and examination of all parts, together with all repairs found to be required.

The term "shops" is used to denote any central collection of erecting and machine shops, &c., run as an organisation distinct from the running department and specialising in heavy repairs.

At one time it was possible to obtain a mileage of 100,000 between general repairs, but to-day we have got down to a figure varying between 40,000 and 60,000 miles. Tubes will only last for about 20,000 miles, after which mileage it will be necessary to take out a group, roughly following the outline of an inverted V, and consisting of about a third of the total number. Their withdrawal will allow of the removal of the accumulation of dirt from around the tube necks which has caused them to leak, and so brought about the need for retubing. Here it should be added that the tube mileage is very dependent on the quality of water in general use, chalky water, for instance, reducing the tube mileage very considerably. An increasing number of tubes have to be removed at the second and third retubing.

The usual way of removing tubes is to cut them off at the smoke-box end just inside the tube-plate with a small electric saw, and then to make a longitudinal cut with a cross-cut chisel in them at the fire-box end, close them in for about a couple of inches with a hammer and tool and thus free them in the tube-plate. Certain convenient holes in the smoke-box tube-plate are left larger—being made up with thin copper sleeves to the right diameter when tubing—and the sawn-off ends, together with the copper sleeves, are cut out of these holes, and all the freed tubes are passed out through them. In sheds where no current is available, the smoke-box ends have to be closed in the same way as the fire-box ends, and the tube then has to be pushed back into the boiler far enough for its front end to clear the tube-plate. If the body of the tube is good enough it is frequently the practice to saw off the damaged ends and to weld or braze a new piece on to bring the length up to standard. Modern practice in retubing is to expand the ends slightly when in position with a conical drift and hammer and then to expand them with roller expanders, ferrules not being generally used.

Roughly speaking, retubing or "sifting the tubes for dirt," as it is sometimes called, will occur about every six months, so that in a shed of the capacity here discussed there will always be about three engines per week laid off for this purpose, and in




to allow of the fires being thrown direct into ballast wagons placed for the purpose on the sunk road. The inwards road should then lead on alongside the coal stage, and then be connected with the inward "fan" of roads leading into the running shed. There ought to be loops short-circuiting the turntable, inwards road and coal stage, so that engines can be passed along, avoiding any one or all of these sections. Such a road is very useful in the case of an engine having to be coaled or turned in an emergency, which event is bound to happen from time to time.

The outwards "fan" of the running shed should be connected to an out-going siding, with the same connections as for the in-going siding. In many cases one siding and set of connections to the main line are used for both inwards and outwards bound engines, but in busy sheds that arrangement is apt to lead to delay. Another very useful emergency connection is one between the out-going siding and the turntable, which allows of an emergency turning at the last moment without upsetting the working.

Except where coal is weighed out, automatically or otherwise, the booking of coal quantities to specific engines is more or less of a farce, and should be discontinued. The usual way is to have "tubs" which hold approximately half a ton, and to book the number of tubs emptied to the engine. There is no guarantee of anything near accuracy unless these tubs are each properly weighed, and, in balancing up, any shortage found is apt to be booked somewhat casually.

In the last section cold washing-out only was referred to, but it is better that in a shed steaming fifty or more engines daily a proper hot-water washing-out plant should be provided, as, by so doing, engines need only be out of steam for about three hours, instead of for about twenty, as with the cold process. The record time within the writer's knowledge is 2¾ hours from train to train. In addition, the hot-water plant enables the margin of spare engines to be reduced considerably, not only of engines belonging to that particular shed, but of engines from other sheds which can be worked in the routine course of traffic, so that they arrive for washing-out purposes at the shed provided with the hot washing-out plant. Additional major plant required would be a sand and lighting-up furnace and a "wheel drop," of which more later.

Buildings required for administration purposes would include the chief foreman's private office, the clerks' office, an office for the mechanical foremen and shedmen, and a large room for the signing on and off of the enginemen. This room should have screens

order to get them done to time two shifts of tubers—two men per shift—will be needed. It takes about 1½ to two days to renew about 100 tubes, which is roughly the general average tackled on these occasions. It is good practice when the engine is laid off for retubing to overhaul valves and pistons and to adjust big ends.

Defects in stays are either small heads or breaks. Broken stays are detected with a hammer, and provided that there are not more than about six defectives close together can be replaced by "steam tights." If this number be exceeded it will probably be both necessary and economical to lift the boiler out of the frames in order that the outside end of the new stays may be properly riveted over, and that the job can be tackled from both inside and outside the box. The bulk of defective stays usually occur in places impossible of external access without lifting the boiler.

To remove defective stays with the boiler in place it is necessary to drill the stay out of the fire-box plate and then break off the piece between the inner and outer boxes with a hammer and tool, allowing the broken-off piece to fall down the water space, whence it can be dislodged with wires through the wash-out plug holes. The end remaining in the outer fire-box is then drilled out and the holes retapped, the outer thread being left "steam tight" size. The stay is then turned in with a wrench and hammered over on the fire-box end. The evil of this system is that considerable torsion has to be applied to the stay in order to secure its steam tightness in the outer plate, and, also, it cannot be known whether a stay so fitted is actually steam tight externally. Moreover, the operation is comparatively slow, and I think that it pays to lift a boiler for the renewal of twelve or more stays, which is usually speaking a shops job, although the boiler could be lifted out by the breakdown gang crane, provided such an one of sufficient capacity is attached to the shed in question.

Diagrams of tubes and stays of each engine should be kept in the forman mechanic's office. On one the condition of each stay can be marked by symbols, *i.e.*, an X for a broken stay, an O for a small head, an S for a steam tight, &c. On the tube diagram the date of insertion of the various tubes can be noted, and also the condition at last examination and similar remarks, the whole forming a very valuable record. The diagrams can be blue prints produced in numbers for each class of boiler by the drawing-office at a trifling cost.

The method of using the hydraulic "wheel drop" is to bring the engine with the wheels and axle requiring attention immediately over the centre of the ram rails. The wheels and axle are then freed of all attachments, and the ram lowered away to the bottom of the pit; the engine can then be dragged away clear over the dummy rails, and the ram with the wheels be raised to the track level again, when the defects can be easily attended to. The process is reversed for replacement. Locking bolts prevent the possibility of the ram or dummy rails moving when not desired. A near-by hydraulic capstan for moving the engines about will save a lot of labour with pinchbars.

The advantage of this appliance over the old-fashioned sheer legs is one of time. To deal with a hot axle-box under the sheer legs meant laying the engine off for at least twenty-four hours, but with a wheel drop the same operation can be done in three or four hours without emptying the boiler or letting out the fire, this being a specially advantageous point in a shed operating a big express passenger service on a small margin of suitable engines.

In arranging a running shed it is well for the repairs road to be next to the shed wall, observing that the mechanics' stores and fitting shop would naturally be built against it. The washing-out road would preferably be next to the repairs road.

The equipment of a fitting shop would include a faceplate lathe for axle-boxes and big end brasses, another lathe suitable for piston and valve rods, and a small lathe for details, a planing or shaping machine for axle-boxes, and a large and a small drilling machine. The boilermakers require a punching and shearing machine, and, in addition, a couple of smiths' hearths with anvils. A white metalling furnace should be provided.

Repairs required are entered in the repairs book by the drivers as they come in, and the foremen mechanics or their examiners keep in touch with the book and arrange their men as required, taking care to advise the shedmen immediately if the repair is such as will cause the engine to miss its booked turn. It is good practice to keep an "engine stopped for repairs" book in which all stopped engines are entered daily and initialled by the foremen stopping them. A note is made, also, of the number of days before the engine will again be available. This book should be kept in the duty list inspector's office, and should be gone through daily by the shed foreman in consultation with his foreman mechanics. From it the duty list inspector will be able to see at any time what engines have been stopped or what repairs completed, and will be able to judge roughly when he may expect engines stopped for repairs to be again available. It also gives him the valuable chance of asking the foremen mechanics to push on with a needed engine at the possible expense of less needed ones.

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THE British Commercial Agent at Batavia has forwarded a memorandum regarding the introduction of the metric system as the sole standard of measure and weight to be used in future in the Netherland East Indies. British firms interested may consult the memorandum referred to on application to the Department of Overseas Trade, 35, Old Queen-street, London, W. 1.

## Velocity of Wind in Conical Ducts.

By A. THOM and J. SMALL.

THERE have been recurring suggestions that the modern windmill might be much improved in the matter of power developed with a given diameter of wheel by directing the wind upon the wheel through a conical duct. No experimental evidence has hitherto been available to support or to disprove the speculations on this matter.

The following short investigation was undertaken with a view to supplying some data bearing on the subject. The results obtained, it may be said, do not seem to establish a case for the suggested arrangement when the practical aspects of their application are taken into full consideration.

In the first experiments carried out, wind velocities were measured at points along the axes of conical funnels of chosen size and shape, the direction of the axis in each case being the direction of the wind current. The funnels were made up of thin tin-plate and were suitably mounted for placing centrally in the wind channel.

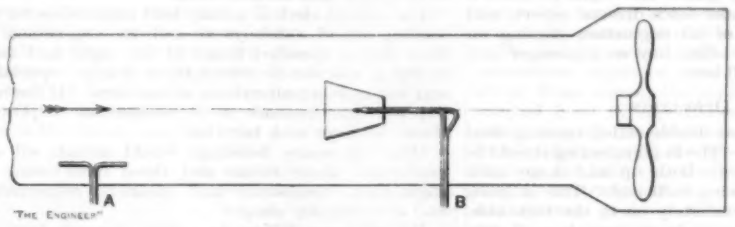



FIG. 1 EXPERIMENTAL WIND CHANNEL

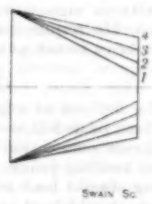
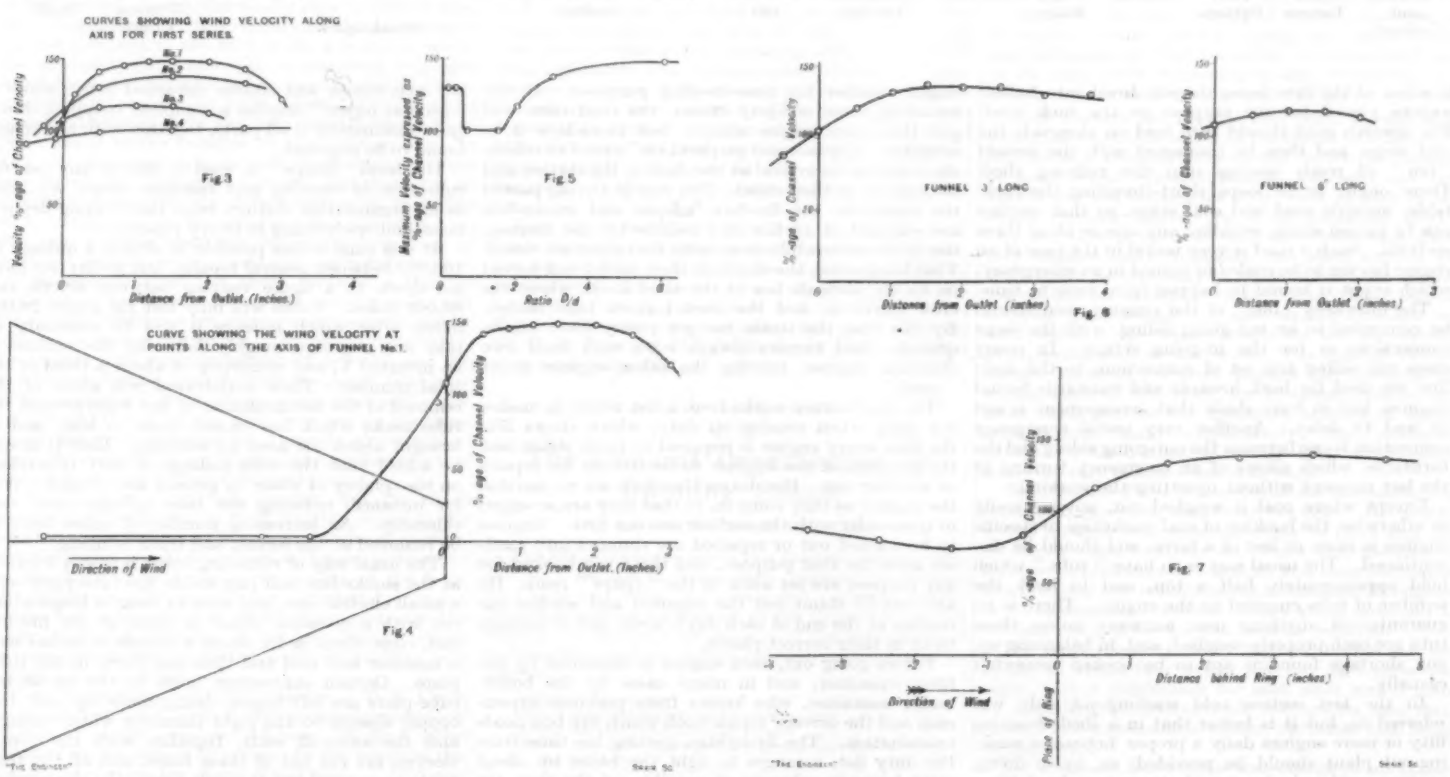



FIG. 2

The wind channel used was of square section with a motor-driven fan at one end. The velocities were determined by means of Pitot tubes A and B—Fig. 1. The tubes A were led to a water manometer which was read by means of a microscope. The tubes B were connected to a Chattock tilting gauge. A calibration was made in the first place of A against B. Therefore A indicated the normal wind velocity in the channel, while B indicated the velocity under investigation. Simultaneous readings of A and B always afforded a measure of the velocity under investigation relative to the channel velocity. Throughout the tests the channel velocity was kept as nearly as possible at 20ft. per second.

A series of funnels was made up with equal axial lengths (6in.), and with the same diameter at the large end (6in.). The small end diameters of the funnels Nos. 1, 2, 3 and 4 were respectively 1in., 2in., 3in. and 4in. Fig. 2 shows their relative forms.

Each funnel was in turn placed with its larger end towards the wind, and the wind velocity was measured at points along the axis. The results are shown by the curves in Fig. 3. It will be observed that in each case the maximum velocity occurs at a point between 1in. and 2in. from the funnel outlet, and in the case of funnel No. 1 the maximum relative velocity is 148, regarding the normal channel velocity




FIGS. 3 TO 7—CURVES OF WIND VELOCITY

as 100. That is to say, the wind velocity is increased by 48 per cent. in passing through funnel No. 1. The other funnels with larger outlet diameters show correspondingly less speeding up, and in the case of funnel No. 4 (diameters 6in. and 4in.) the velocity

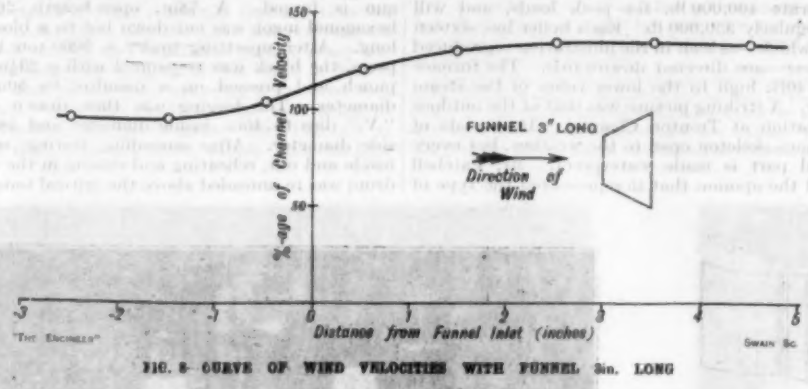
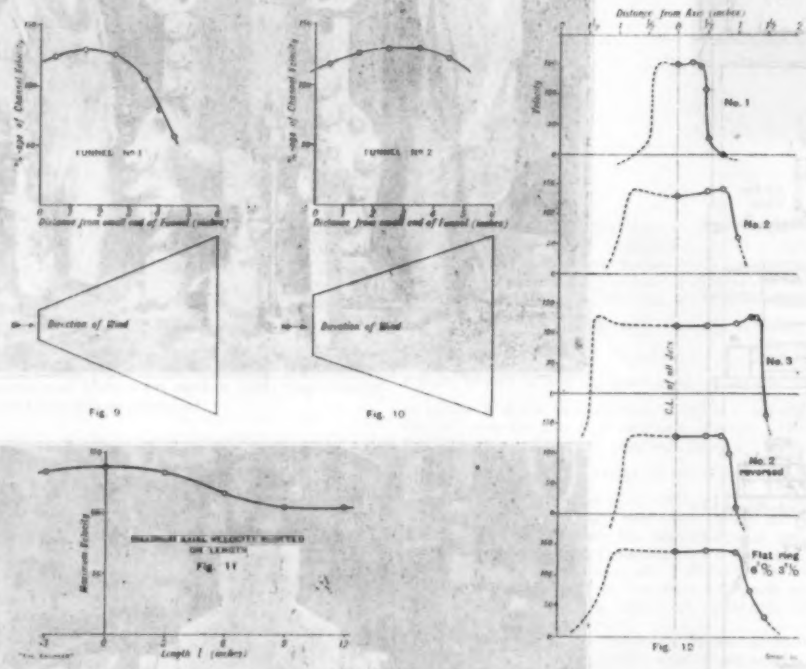



FIG. 8. CURVE OF WIND VELOCITIES WITH FUNNEL 3in. LONG

of the issuing air practically corresponds with the channel velocity. It is apparent that, for the given length and inlet diameter of the funnels, an outlet diameter less than 4in. is required before there is any appreciable increase in air speed.

This also includes cases in which the small end of the funnel was directed towards the wind. This extension of the investigation suggested itself when the second series of funnels was being dealt with.

The second series consisted of funnels all with end diameters of 6in. and 3in. respectively, but with lengths 3in., 6in., 9in., and 12in. Velocities were measured at points along the axes of these in turn. The curves shown in Fig. 6 indicate the results obtained on the first two funnels. The greatest




FIGS. 9 TO 12

The curve in Fig. 4 represents the velocity of the air along the axis of funnel No. 1 from the inlet. The velocity for the greater part of the distance within the cone is only a small fraction of the channel velocity. The conversion to velocity head definitely commences within 2in. of the outlet.

The maximum velocities obtained with this series of funnels are shown plotted in Fig. 5 on a base of D/*d*, where D is the inlet and *d* the outlet diameter. increase in velocity occurred with the shortest funnel, 3in. long. The maximum velocity decreased so rapidly with increase of length as to show that the 3in. interval in the lengths was too great to afford a satisfactory investigation of the effect of length.

The series of funnels of different lengths logically includes the funnel of no length, that is, a thin flat ring. Such a ring was made up from thin tin-plate, its diameters being 6in. and 3in. Velocity measurements at points along its axis were made and are plotted in Fig. 7. The maximum velocity occurs at a section considerably removed from the plane of the ring and is slightly greater than that obtained with the funnel 3in. long. A flat ring, therefore, when presented to the wind, gives a greater speeding-up of the air passing through it than any conical duct having inlet and outlet diameters equal respectively to the outside and inside diameters of the ring.

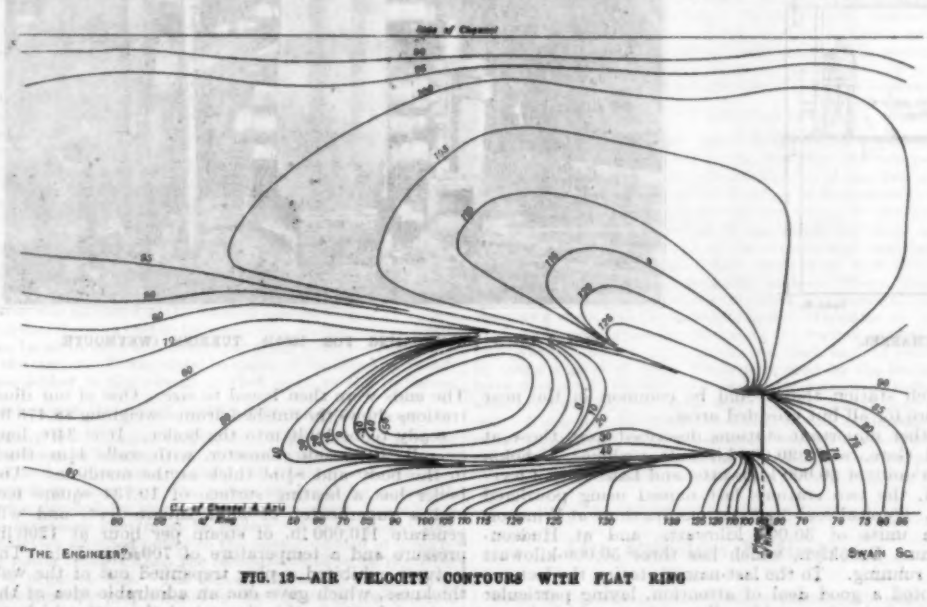



FIG. 13—AIR VELOCITY CONTOURS WITH FLAT RING

The series consisting of funnels whose lengths vary down to zero suggests an extension of the series by reversing the position of the funnels in the wind so that the smaller end is presented to the current. This may be regarded for graphical purposes as introducing funnels of negative length. The funnel, 3in. long, belonging to the second series was set up in this way. Fig. 8 shows the velocity of the wind along the axis. In this case the maximum velocity is practically the same as that obtained with the funnel the other way round.

To test this result in its application to other funnels the curves in Figs. 9 and 10 were obtained from funnels Nos. 1 and 2 of the first series with these reversed in the wind. The maximum velocities obtained were 130 and 130, compared with 148 and 138 respectively in the original position.

Fig. 11 is a curve of maximum velocity plotted on a base of length (*l*) for the second series of funnels; *l* is regarded as positive when the large end is facing up stream.

The foregoing results have shown that a jet of air issues from funnels which possess suitable cone angles and diameter ratios, with a velocity considerably in excess of the normal channel velocity. It remained to investigate the variation in the velocity of the air from point to point across the section of the jet. This was done on funnels Nos. 1, 2 and 3 of the first series and on the ring. The section explored in each case corresponded with the position of maximum velocity on the axis. The velocities obtained for a series of points at different distances from the axis are plotted in Fig. 12. It will be seen that the velocity remains practically constant across the issuing jet, which has in each case a diameter approximately equal to 90 per cent. of the outlet diameter. One half of each curve is drawn from observation; the other half, shown dotted, being drawn from considerations of symmetry.

A complete investigation of the velocities parallel to the axis and in a horizontal plane containing the axis was made on a flat ring with diameters 4in. and 2in. The results are shown as a series of velocity contours (for one half of the ring) in Fig. 13. It will be seen that the jet of high velocity air is maintained for a considerable distance behind the ring. The lines indicating negative velocities show the presence of eddies. The figures on the contour lines are relative, the channel velocity being taken as 100.

The available power varies as (air-speed)$^3$. Consider then the increase in the power available at the plane of maximum velocity in the case of, say, funnel No. 1. If the diameter of the stream of high velocity air were the same as that of the funnel outlet, the new amount of power available would be to the old as $(1.48)^3$ to 1, or 3.24 to 1. This ratio is affected by the decrease in the diameter of the high-speed air stream, reducing it to about 2.6 to 1. This apparently large increase in available power is obtained only by using a duct, the inlet and outlet diameters of which are as 6 to 1—a ratio which would be impracticable with wheels of the size in general use.

The practical application of these results is further complicated by the fact that the maximum velocity occurs at a considerable distance from the neck of the funnel.

A case which represents more practicable proportions is that of funnel No. 3, but here the increase in velocity amounts only to 20 per cent., representing a possible increase in power of 70 per cent.

The same increase in power may be obtained by using a wheel only 30 per cent. greater in diameter.

## DEEP MINING ON THE RAND.

THERE are two mine shafts on the Central Rand which are sunk to a vertical depth of over a mile and are to go still deeper. The City Deep's deep shaft cut the South Reef a little while back and is now close to the Main Reef Leader, at a vertical depth of 6038ft. The shaft will be continued to a depth of close on 7000ft., and ore, men and tools will be dealt with in two-stage hoisting, the first haul being from 4500ft. At City Deep's western neighbour, the Village Deep, the Turf shaft has been sunk to the thirty-sixth level and has reached a vertical depth of 6600ft. from the surface. In this property hoisting is carried out in three stages, and the third hoist, operating on the thirty-second level at a depth of over 6300ft. has just recently been installed. It is 1200 horse-power and believed to be the deepest underground large machinery in the world. These two shafts are the deepest pits that have been sunk by gold mines operating on such a large scale—City Deep mills 100,000 tons monthly and Village Deep between 50,000 and 60,000 tons. The St. John del Rey mine in Brazil had reached a vertical depth of 6726ft. early in 1922, and as it increases in depth at the rate of 150ft. per year it is no doubt now over 7000ft. in depth. The output of the St. John is, however, only about 11,000 tons monthly.

## Super Power Stations in America.

ON Monday evening, March 2nd, Mr. W. H. Patchell, immediate Past-president of the Institution of Mechanical Engineers, delivered the annual lecture to the Graduate Section of that Institution, taking as his subject the great coal-fired power stations of the United States. Using a large number of slides, he was able to convey to his audience some idea of the vast size of the plant which is now being used in America, and particularly of the enormous boilers which characterise the most recent stations. He spoke of the combustion chambers of the boilers in the Trenton Channel power house of the Detroit Edison Company, for example, as resembling "cathedrals rather than fire-boxes." When we remember that some of these combustion chambers, designed for the burning of powdered coal, run up to 50ft. and even 60ft. in height, we can sympathise with this view. Mr. Patchell devoted a good deal of his time to powdered fuel installations, and by means of admirable diagrams explained very lucidly the elaborate machinery which is required for the pulverisation and conveyance of coal to the burners. He dealt also with the problems presented by combustion at very high temperatures, and showed pictures of the water screen at the bottom of the combustion chamber, which prevents the fused clinker from settling as hard cake, and of the finned tubes which are now being built up, like sheet piling, in the side walls of boiler furnaces.

The first station with which the lecturer dealt was that at Trenton Channel, where three 50,000-kilowatt turbines are already at work. The boilers are of the Stirling W. type, and have a heating surface of 29,000 square feet. They are rated for an output of 100,000 lb. of steam per hour each, but can generate 400,000 lb. for peak loads, and will deliver regularly 350,000 lb. Each boiler has sixteen burners, which—as seen in the illustration reproduced from *Power*—are directed downwards. The furnace is about 40ft. high to the lower tubes of the steam generator. A striking picture was that of the outdoor switch station at Trenton Channel. It consists of an enormous skeleton open to the weather, but every individual part is made waterproof. Mr. Patchell expressed the opinion that it represented the type of switch station that would be common in the near future for all but crowded areas.

Other important stations described were those at Hell Gate, with 30,000-kilowatt turbines, Cahokin with units of 30,000 kilowatts, and Lakeshore, Cleveland, the two stations last named using powdered fuel. Typical coal-fired stations are those at Windsor, with units of 30,000 kilowatts, and at Hudson-avenue, Brooklyn, which has three 50,000-kilowatt sets running. To the last-named station the lecturer devoted a good deal of attention, laying particular stress upon the coal-handling plant, which has a capacity of no less than 300 tons per hour. An important detail of this station is a 35,000-kilovolt-ampère frequency changer.

Amongst the many stations described, with several of which the lecturer is personally connected, and has himself recently inspected, perhaps one of the most interesting is that at Weymouth, Boston, where a boiler for 1200 lb. pressure is to be used. With the help of a series of slides, Mr. Patchell showed how the steam drum for this boiler was forged by the Midvale Company, Pa., from a steel ingot, much as a great gun is forged. A 78in. open-hearth 262,000 lb. hexagonal ingot was cut down hot to a block 156in. long. After upsetting under a 9000-ton hydraulic press, the block was trepanned with a 23¼in. hollow punch and pressed on a mandrel to 50in. inside diameter. The forging was then drawn down in "V" dies to 45in. inside diameter and 58¼in. outside diameter. After annealing, testing, machining inside and out, reheating and closing in the ends, the drum was re-annealed above the critical temperature. The ends were then bored to size. One of our illustrations shows the finished drum—weighing 88,475 lb. —ready to be built into the boiler. It is 34ft. long overall, 4ft. inside diameter, with walls 4⅛in. thick in the body and 8½in. thick at the manholes. The boiler has a heating surface of 19,734 square feet and a superheater of 3871 square feet, and will generate 110,000 lb. of steam per hour at 1200 lb. pressure and a temperature of 700 deg. Fah. The lecturer exhibited a plug trepanned out of the wall thickness, which gave one an admirable idea of the contrast between this drum and those to which we are accustomed. Through the courtesy of Mr. Patchell we are able to reproduce several illustrations, showing the production of this drum. The illustrations of the casing for the 2500-kilowatt turbine, which is to be used with this boiler, which are given in the half-

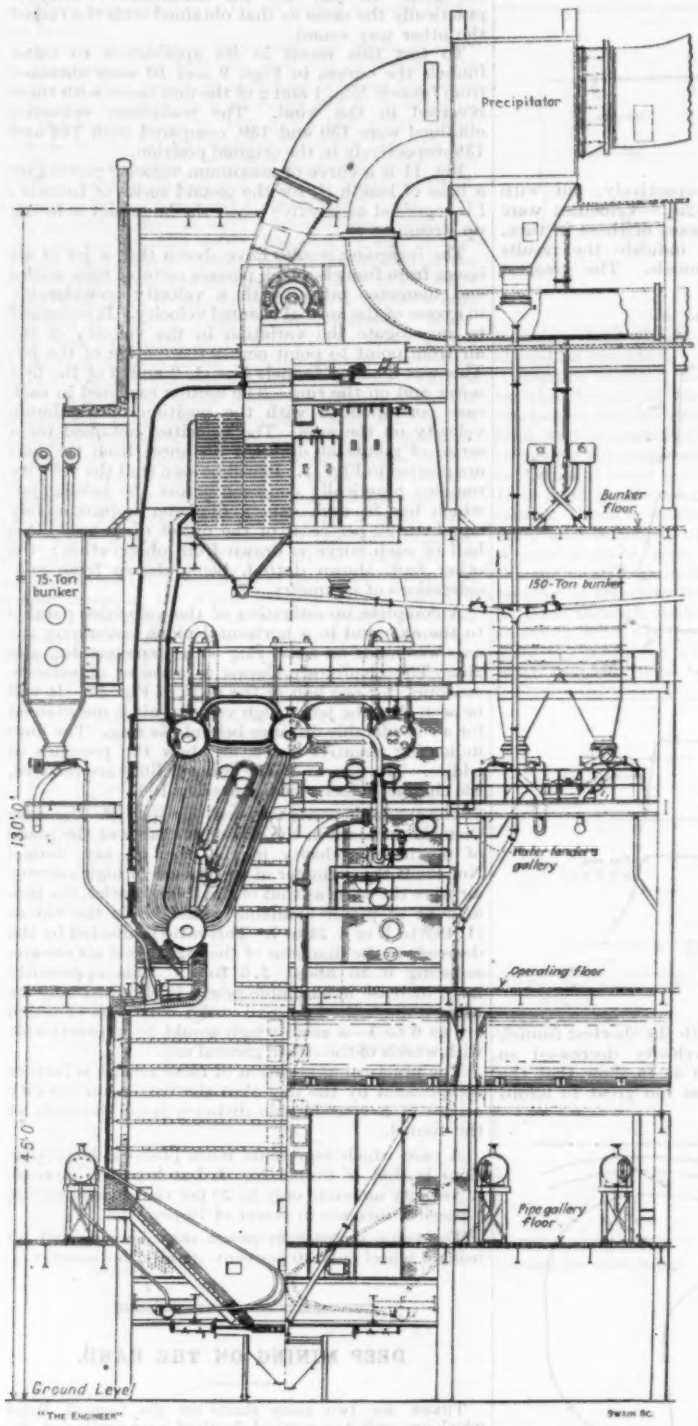
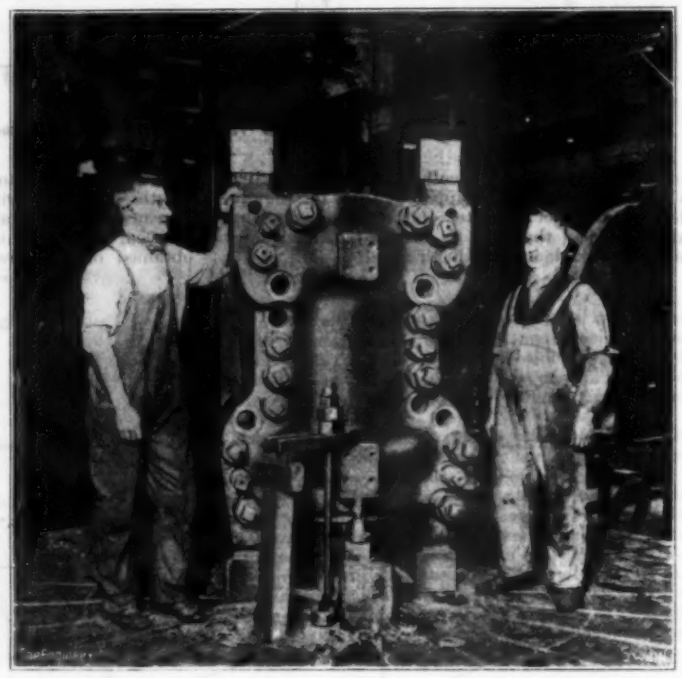
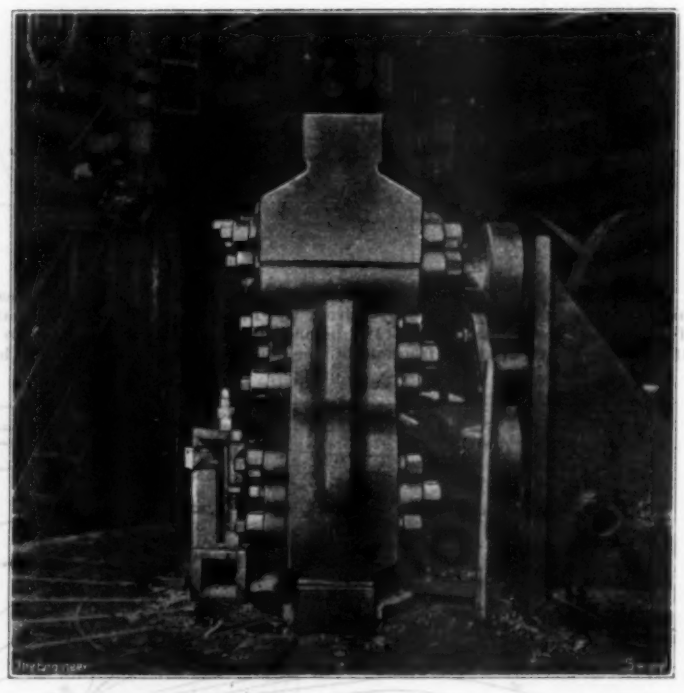



FIG. 1 SECTION THROUGH BOILER-HOUSE (TRENTON CHANNEL)





FIGS. 2 AND 3—HALF CASING FOR 1200 lb. TURBINE (WEYMOUTH)

tone engravings Figs. 2 and 3, were equally striking.

We have not attempted to deal with the mass of figures which Mr. Patchell gave, but we may express a hope that they will duly be recorded in some accessible place. It is difficult for most engineers in this country to get themselves into a line with the vast proportions of these American plants. Here we live on a smaller scale, our distances and our outputs are so much smaller that we find it hard to grasp the scale of stations which regularly use units of 50,000 kilowatts, and have boilers towering a hundred feet into the air. Whether we, here, shall ever think in such dimensions cannot be said. Mr. Patchell is convinced that if our electrical supply undertakings showed the enterprise and pushfulness of American suppliers, then we, too, could find economical employment for much larger stations. Whether he is right in that view or not, we do not pretend to say, but we may at least agree with him that those who, like him, have the advantage of intimate acquaintance with these huge power houses serve their own country well in bringing home particulars about them, and giving engineers of their own nation such impressions as they have themselves received.

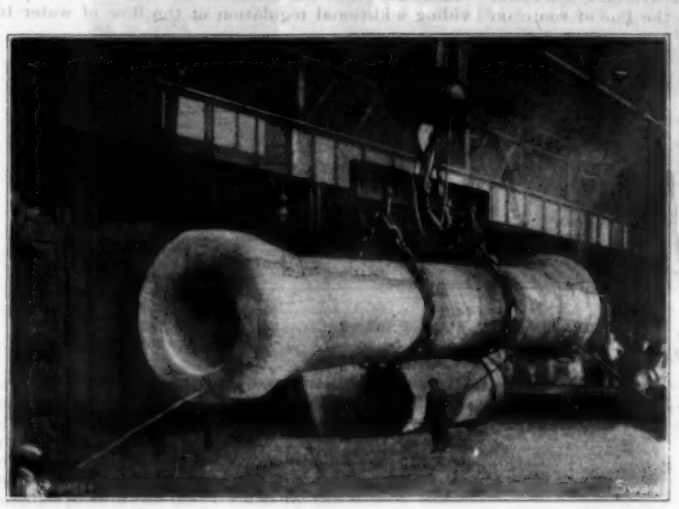


FIG. 4—PARTLY FORGED DRUM FOR 1200 lb. BOILER (WEYMOUTH)

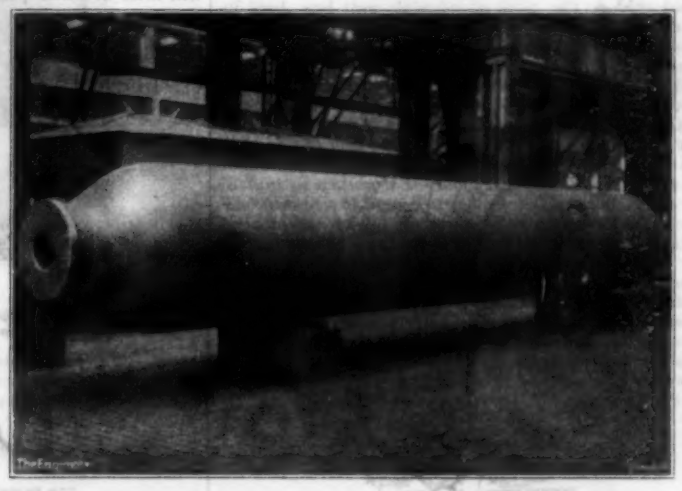


FIG. 5—COMPLETED STEAM DRUM FOR 1200 lb. BOILER (WEYMOUTH)

## Resistance in Wireless Circuits.

A VERY instructive lecture on "Resistance in Wireless Circuits" was delivered on Wednesday, February 25th, by Professor C. R. Fortescue before the Radio Society of Great Britain. Resistance, he said, was as essential and as unavoidable in wireless circuits as it was in any electrical apparatus, and the problem involved was the same. It was first essential to decide upon an appropriate value for the resistance of each part of the circuit, and then to maintain it at that value. But whereas in most electrical machinery the permissible temperature rise placed a limit on the resistance, in wireless circuits efficiency considerations were generally the determining factors. In the case of large transmitters, however, both limitations were met with. The simplest measure of the resistance of a conductor was given by Ohms' law, $R = \frac{V}{I}$. The power wasted in heat in the circuit was $I^2R$, and this gave an alternative measure of resistance, i.e., $R = \frac{W}{I^2}$.

When dealing with wireless circuits, the first measure was ruled out, because a large share of the applied voltage was usually required to overcome the effects of inductance and capacity. The alternative measure derived from the power generated as heat might, however, be used with certain conventions. Power was expended as heat in various ways, and it became necessary to extend the term resistance loss to include the whole heat generated by the presence of the current in the circuit, and the effective resistance might then be defined as $R' = \frac{W'}{I^2}$, the current being measured in R.M.S. amperes.

In those circuits in which an appreciable amount of power was radiated in the form of electro-magnetic waves, a further decision had to be made, viz., should this expenditure be included when determining the effective resistance of the circuit. It was usual to speak of the effective resistance added to the circuit in that way, as the radiation resistance of the circuit, and to define it as $R = \frac{W''}{I^2}$.

Many instruments, valves, &c., might also have to be considered as forming part of the circuit under consideration, and still further addition to the resistance might arise from their presence. The power absorbed by any such device divided by the mean square current, again gave the resistance that must be added. If it happened that the device supplied power to the circuit instead of absorbing power from it, then the resistance had to be regarded as a negative one. The power supplied was generally approximately proportional to the square of the current, and the negative resistance was then as much a constant of the circuit as the ordinary positive resistance.

If the negative resistance exceeded the positive resistance, the power supplied to the circuit for any current I was greater than the power expended. The excess power caused an increase of the current, and that increase would continue indefinitely if the positive and negative resistances were really constant. An oscillating valve just building up the current was an example of a negative resistance predominating. The current went on increasing until a steady value was reached, when the current output from the valve no longer exceeded the power expenditure, owing to the negative resistance of the valve not being truly a constant and having fallen as the current increased. Any device giving a negative resistance necessarily had a limitation of that kind, unless it was capable of supplying an infinite amount of power.

Dealing with the practical importance of resistance, the lecturer said that that depended on the part of the installation. In the high-frequency tuned circuits, it was necessary to reduce the resistance to a low value. The selectivity or the sharpness of the tuning of a receiving circuit was dependent upon the ratio of the resistance to the inductance. If two continuous waves differing in frequency by 1 kilo.-cycle induced the same electromotive force in an aerial tuned to one of them, the ratio of the powers absorbed from the two sources of electromotive force was approximately $1 + 100 \frac{L^2}{R^2}$, L being in millihenries and R in ohms. At a frequency of one million, or a wave length of 300 m., good design gave the value of $\frac{R}{L}$ as about 3 ohms per millihenry for the inductance of a size suitable for use in a receiving circuit. That gave a ratio of powers absorbed of about 19 to 1. If the ratio of $\frac{R}{L}$ could be reduced to about .3 ohms per millihenry, the ratio would become 180 to 1. When it was remembered that an interfering signal was often much stronger than the signal being received, the desirability of reducing the resistance relative to the inductance became obvious. Those considerations applied, however, to modulated continuous waves, and in the case of spark and atmospheric interference, the effect of resistance was quite small.

In dealing with the dielectric losses in inductances, Professor Fortescue explained that those might occur in the insulation of the individual conductors or in the former supporting the coil. The loss in the insulation of the conductors might be avoided by the adoption of air spacing. That, however, was not always permissible, and in that case it was necessary either to keep the insulation quite dry or to impregnate it with a non-hydroscopic varnish of good dielectric properties. The solvent used in making shellac varnish always contained water, which could not be driven off permanently. With cotton insulation, shellac varnish had serious disadvantages, and with single-layer coils, which were not actually exposed to water, it seemed preferable to leave them unvarnished. In some cases the dielectric loss in the former of coils was important. In a variometer recently tested, a ratio of $\frac{R}{L}$ of about 800 ohms per millihenry was found, owing apparently, Professor Fortescue stated, to the fact that the two parts of the outer winding were not directly in series, but were separated by the whole of the winding of the moving coil, and consequently the rather narrow strip of insulating material between the halves of the outer coil were subjected to the whole voltage of the moving coil, and being of moulded material, the losses there were sufficient to render the variometer practically useless. When placed in the circuit for which it was intended, the resistance and reactance were approximately equal! Troubles of that kind could be avoided by designing the former so that no part was exposed to a strong electric field, and, of course, by using a good ebonite. Tests described by the lecturer have shown that heavy brass terminals outside an inductance are harmless, but steel must not be placed near the coil. A case was mentioned in which the act of moving an aerial tuning coil in a transmitting station up to within a few feet of a steel-framed valve panel, led to an expenditure of something like 10 kilowatts in the panel itself.

## The Radium Industry.

SOME figures issued by the Radium Chemical Company of America, said Major Charles E. S. Phillips, in a paper read last Friday before the Institution of Engineering Inspection, show that in order to obtain one gramme of radium an average of 500 tons of carefully sorted ore and the use of about 500 tons of various chemicals, the power from 1000 tons of coal, the use of some 10,000 tons of purified and distilled water, and the labour of 150 men for a month are required. The paper is entitled "The Radium Industry, its Development and Importance," and it contains a great deal of interesting information concerning the production of radium and its uses. The largest and most important organisation for the preparation of radium salts in the world is under the control of the Compagnie Radium Belge. During the mining operations for copper carried out in the Belgian Congo by the Union Minière du Haut Katanga—of which the above-named company is a branch—vast quantities of uranium bearing ores were discovered. Up to the end of 1922 some four-fifths of the world's supply of radium came from the United States, but at the present time no less than 96 per cent. of the radium produced comes from the Belgian Congo. After the ore has been sorted it is packed in sacks and is taken by road to Beira, a distance of 1600 miles, for shipment to Oolen near Antwerp, where it is crushed and chemically treated for the extraction of radium.

The processes adopted for this purpose vary somewhat throughout the world, depending, of course, on local conditions, the nature of the ores, and so on. Broadly, however, the course followed consists in bringing the radium into a form in which it may be readily separated from the other metals present. Treatment with sulphuric acid then converts the radium into a sulphate, and the addition of barium and suitable washing enables the other constituents to be removed and the radium and barium to be separated together. The next step consists in the conversion of this mixture into a suitable form for treatment with hydrochloric acid, the two substances being finally separated from the solution by fractional crystallisation. It is a long and difficult process, but in the end radium chloride is obtained of great purity and issued for use either in that form, as bromide, or more commonly as sulphate.

As the result of the medical uses of radium a branch industry has arisen for the production of instruments, applicators, &c., that are required in the course of treatment. In spite of the great efforts that has been made to produce radium, the total quantity so far isolated in the whole world only amounts to about 8 oz. Radium was used during the late war for the purpose of rendering gun sights faintly luminous, and therefore visible at night. A more sinister use consisted in the preparation of a weak radium solution, which, being absolutely invisible on paper, could be used to write a secret message between the lines of an ordinary letter, which might therefore pass the censor and safely reach its destination. If laid in contact with a photographic plate for an hour or so, the message becomes visible after the plate has been developed.

The author exhibited two gun sights fitted with small glass tubes filled with zinc sulphide, combined with a trace of radium. The bombardment of the zinc sulphide crystals by the alpha rays from radium renders that substance luminous. The fact was known years before the war, but it was never applied to any practical purpose until it was suggested that the face of a watch or compass card might be coated, so as to enable them to be used in the dark. The first military compasses constructed on these lines were made as early as 1909.

Many practical difficulties connected with the use of radium during the war were overcome by Mr. Harrison Glew. During the war the Government purchased five grammes of radium, and Mr. Glew's first batch of gun-sight tubes numbered no less than 240,000.

POWERS were given to the Board of Trade in 1840 to secure the safety of new railways before opening them for public traffic, and were strengthened in 1842. Apparently, some ignorance prevailed among railway engineers as to the essentials the inspecting officers required before they would certify that the line submitted could be opened without danger to the public, and so, in April, 1858, a list of requirements was issued. They have been amended from time to time, and the last edition was dated February, 1914. One of the early useful activities of the Ministry of Transport after its formation in 1919 was the revision and enlargement of the requirements, and by conference between the companies and the Ministry, under the chairmanship of Colonel Sir John Pringle, a new list has been agreed to, and has now come into force. Instead of being "Requirements of the Board of Trade in regard to the Opening of Railways," the new document bears the title, "Requirements for Passenger Lines and Recommendations for Goods Lines of the Ministry of Transport in regard to Railway Construction and Operation." It consists of twenty-two pages, foolscap size, and for the first time may be purchased by the public. Copies can be obtained, at 3s. each, from the Stationery Office.

## The Mangahao Hydro-Electric Scheme.

IN the latter part of 1918 a report on the development of the hydro-electric resources of the North Island of New Zealand was prepared by Mr. E. Parry, who at that time was Chief Electrical Engineer to the Public Works Department, and the scheme outlined in that report was subsequently adopted by the Government. It provided for the development of three large water power sites in various

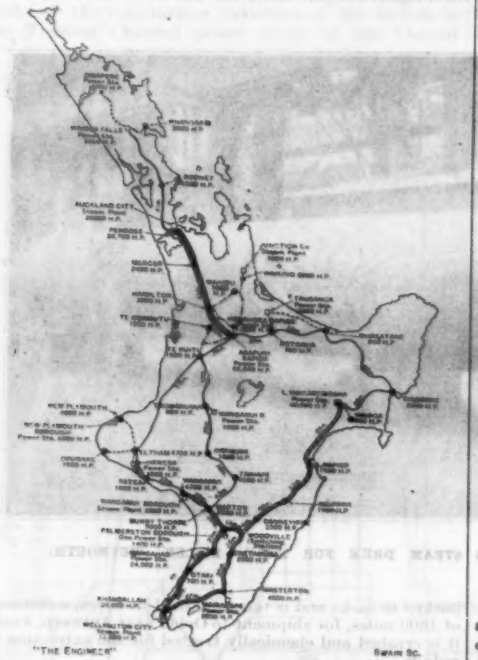



FIG. 1—MAP SHOWING POSITIONS OF POWER PLANTS

parts of the island, the stations being situated (*a*) on the Mangahao River, (*b*) near Lake Waikaremoana, and (*c*) on the Waikato River at Arapuni Rapids—see map, Fig. 1. The amount of energy that it is proposed at first to develop at the three stations is 24,000, 40,000, and 96,000 horse-power respectively, but in the case of the Waikaremonana and Arapuni sites the output can be increased to 130,000 and 160,000 horse-power. The Public Works Department has also purchased the Hora Hora plant, which has a capacity of 14,000 horse-power, from the Waiki Gold Mining Company, and the latter station is to be

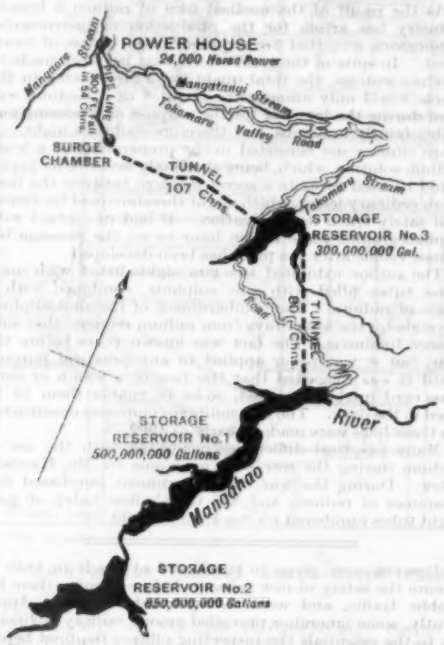



FIG. 2—PLAN OF STORAGE RESERVOIRS

utilised for the supply of power to the South Auckland and Waikato districts.

Mangahao is very favourably situated from the point of view of power supply to the Wellington area. Similarly the Waikaremoana station is in a very favourable position for supplying the south-east coast, but the Arapuni station is rather too far south for the supply of power to the northern area. This slight disadvantage is, however, to some extent compensated for by the fact that the output from the Mangahao station is limited and that it will be necessary in the future for the Arapuni station to augment the supply to the southern part of the island.

Very complete and well-thought-out schemes have been prepared for the transmission and distribution of the power generated at the three stations. A comprehensive network of main transmission lines linking up the three main stations with one another and with existing steam and small water power plants covers the whole of the island, so that no part is left without a supply of electrical energy. Twenty-nine substations are to be erected for reducing the transmission line voltage down to a pressure suitable for local distribution. Whilst the main lines follow the most practicable routes possible to feed the various load centres, the prospects of development in other districts have not been overlooked. It is expected, in fact, that as soon as a supply is available a demand will arise at other points along the line of route on

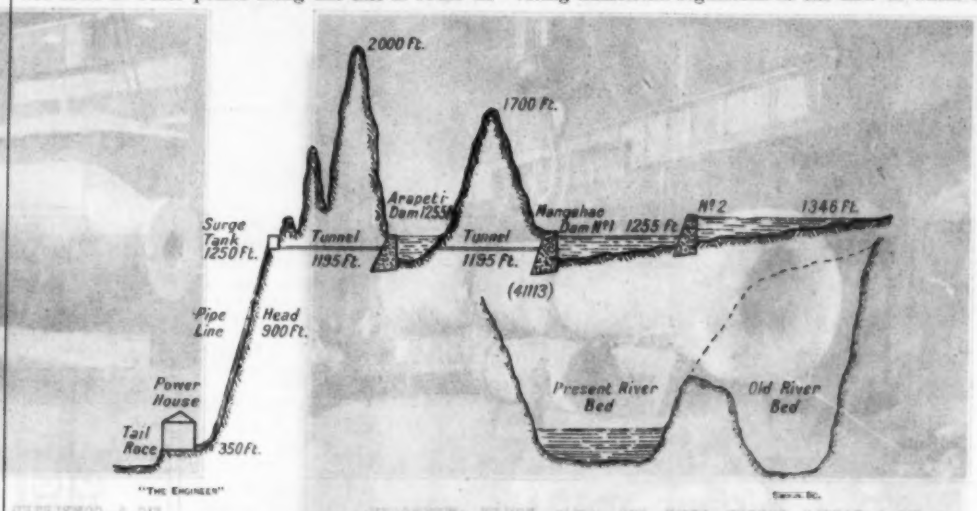



FIG. 3—DIAGRAM OF RESERVOIRS AND OLD AND NEW RIVER BEDS

account of developments in districts in the vicinity of the power lines, which are being operated at a pressure of 110–115 kilovolts. Except in the neighbourhood of the Hora Hora station, where 50,000-volt lines are already in operation, branch lines will be worked at 33,000 volts, whilst local distribution will be carried out at 11,000 volts.

The first of the three main stations to be commenced was that on the Mangahao River, for the site is considered to be favourably situated as regards a large potential load and a quick return on the capital expenditure is expected. As a very large demand from Wellington is anticipated, 12,000 kilovolt-ampères of the total output have been allotted to that district. For the development of this site the first tenders were invited some four years ago, and soon afterwards the work associated with the construction of the power-house, head works, pipe lines, &c., was put in hand, most of the orders for the equipment of this station being awarded to British firms.

The amount of water in the river varies considerably, and to tide over periods of low water it was therefore necessary to impound as much as possible of the water coming down during flood periods. The present scheme provides for two main storage reservoirs, but a third will be added later. The largest of these reservoirs is situated on the Mangahao River, as shown in Fig. 2, whilst the smaller is on the Tokomaru River close to its junction with the Arapeti stream, and the dams necessary for these reservoirs have been named the Mangahao and Arapeti dams respectively.

A large concrete-lined tunnel 7ft. in diameter and about one mile long and driven through a range of hills connects the reservoirs together. From the second reservoir another tunnel has been driven through a second range of hills to the surge tank situated above the power-house, and this tunnel is about 8ft. in diameter and 1¼ mile long. From the surge tank steel pipes extend down the hillside to the power station below, which is built at the junction of the Mangahao and Magatangi creeks. The net head of water obtainable for driving the water wheels after allowing a loss of 30ft. for friction in the pipes is 870ft., but the total fall of water from the projected upper reservoir to the power station will be 995ft. A survey for a third reservoir higher up the Mangahao River has been started with a view to providing additional regulation of the flow of water to the station, and this third reservoir will also serve to stop any shingle that may be washed down the river in times of flood. This, of course, is a matter of considerable importance in the case of power stations that operate on a high water head, as the gradual filling up of the reservoir by the settling of the stones and *débris* reduces the storage capacity, thus seriously affecting the capacity of the station at times of heavy loads. Fortunately, however, the Mangahao River carries with it very little silt and *débris*, notwithstanding that it is subject to wide variations in flow.

The construction of the Mangahao and Arapeti dams proved to be a much more difficult task than the engineers originally expected. Trouble was experienced in the direction of finding a suitable rock foundation for the base of the dams and difficulties arose in consequence of floods. Considerable damage

FIG. 4—EXTERIOR OF MANGAHAO POWER STATION

was caused by the unprecedented rains that occurred in 1923. Preliminary surveys of the dam sites failed to reveal the fact that both the Mangahao and Tokomaru rivers had at some distant period, and for some unknown reason, changed their beds—see Fig. 3—and in the course of time had cut new beds for themselves parallel to the old beds, which gradually filled up with a mixture of gravel, rock and *débris* brought down by landslides and water action, until surface indications showed no abnormal conditions and the actual state of affairs was only revealed when excavations were commenced. This discovery necessitated the construction of a cut-off wall from the end of the dam to the solid rock on the far side of the old channel so as to form a seal to prevent loss of water by seepage round the end of the dam.

The Mangahao reservoir will hold 525,000,000 gallons of water, and the length of the lake formed will be about 1¼ miles. Although the Arapeti dam

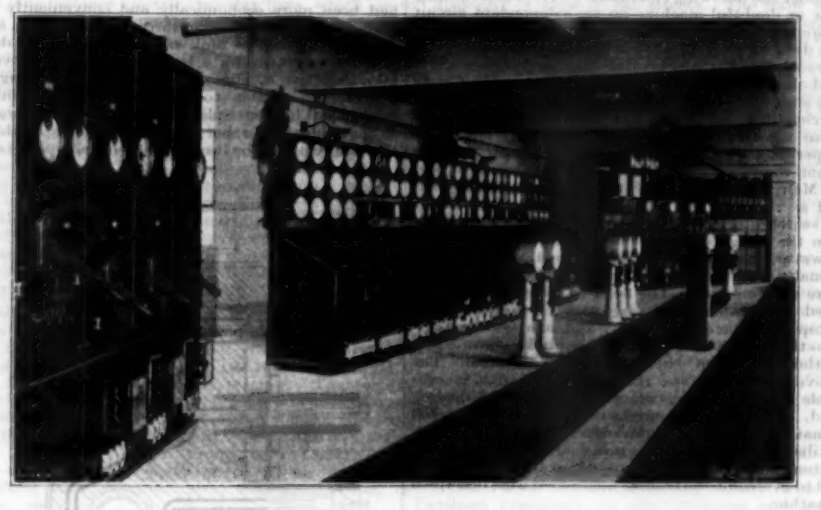


FIG. 5—MAIN SWITCHBOARD

is larger than the Mangahao dam, the storage capacity of the reservoir is not so great. The height of this dam, which is slightly arched, is the same as that of the Mangahao dam, the length being 430ft. and the maximum width 66ft. The amount of water stored, however, is only 290,000,000 gallons, owing to the smaller area of the lake formed by the stored water. The construction of the two tunnels through the dividing hills presented very little difficulty, for both channels run through hard grey rock, which required very little timbering. No. 2 tunnel, connecting the Arapeti reservoir with the surge chamber at two points, is no great distance from the outside surface of the hills, and in order to expedite drilling operations, two adits at right angles to, and intersecting the tunnel line were driven from the hillside, thus enabling drilling to proceed on six faces until the length of tunnel between the adits had been pierced and the haulage of the excavating material was reduced.

Instead of hauling the material to the tunnel mouth, it was dumped at the mouths of the adits, concrete being mixed by machinery at the tunnel mouth and run on trucks on a 2ft. gauge railway. A screen was placed at the entrance to each tunnel to catch *débris* that might have otherwise found its way into the tunnel. To empty the tunnels for inspection purposes, an electrically operated gate has been placed a short distance from each tunnel mouth, and when these gates are closed the tunnels may be emptied and cleared.

The surge chamber is at the head of the pipe line, and it is connected by two short tunnels, 6ft. in diameter, to the two pipe lines, which are also 6ft. in diameter. Some distance down the hillside each steel pipe branches into two pipes of smaller diameter, and just outside the power station one of the pipes is again divided into two smaller pipes. Water is therefore delivered to the station by five pipes, three

FIG. 6—INTERIOR OF POWER HOUSE

of which are 36in. in diameter and two 26in. in diameter. Inside the power station the five pipes are connected by a bus pipe, so that in the event of a fault on any of the pipes outside, none of the machines are put out of action.

The Mangahao station equipment consists of five main generators, each driven by a water wheel of the Pelton type. Three of the generators are designed for an output of 6000 kilovolt-ampères, and two for 3000 kilovolt-ampères, so that the total capacity of the plant is 24,000 kilovolt-ampères. The alternators are excited by means of separately driven exciter units, which may either be driven by water power or by induction motors. All the 3000 kilovolt-ampère sets are also fitted with direct-coupled exciters, and these alternators can either be excited from their own exciters or from the main exciting system.

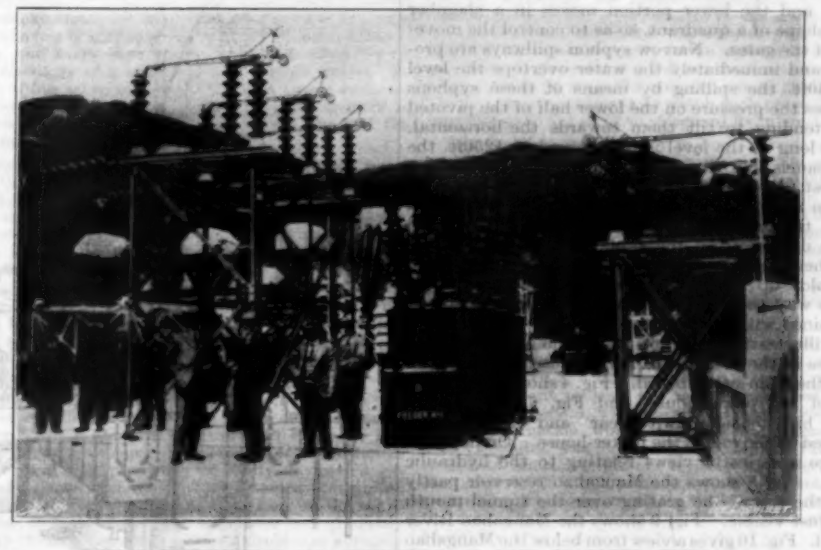


FIG. 7—TRANSFORMERS AND SWITCHGEAR ON ROOF OF POWER HOUSE

The three largest turbines are capable of developing a maximum output of 8000 horse-power, whilst the two smaller machines will deal with 4000 horse-power, the normal outputs being 6450 horse-power and 3225 horse-power respectively. The speed in both cases is 375 revolutions per minute, and the operating head is 825ft. The large turbines have two jets. The smaller turbines are constructed on the same lines as the other turbines, but there is no lower jet. In each case the turbine wheel consists of a cast steel disc on which eleven double buckets are mounted, which are secured to the runner by taper bolts. Automatic oil pressure governors maintain the speed of the turbines practically constant under all conditions of load, and they operate directly on the deflectors and indirectly upon the needles. At times of sudden reductions in the load the deflectors cut into the jets and disperse them. The needles which feed forward slowly are controlled by dashpots, and they gradually cut off the water to the desired extent, the movements of the deflectors and needles being so related that at the end of any governing movement the deflectors rest immediately above the jets ready for instant operation if the load is still further reduced. The rapidity of action of deflector governing and the economy of needle governing are thus combined, and for increasing loads the deflectors and needles are withdrawn.

The two independent exciter units to which we have alluded have a maximum output of 470 brake horse-power and a normal output of 375 brake horse-power at a speed of 750 revolutions per minute. They have single jets, and the governing is done by means of the same system of combined needle and deflector control as is employed on the generating main units.

Current is generated at a pressure of 11,000 volts, and at a periodicity of 50 cycles per second. Districts immediately surrounding the power station are supplied with current at 11,000 volts, and for the supply of current to the auxiliaries in the power-house transformers are employed for reducing the pressure to 440 volts. Two banks of three single-phase transformers, each having a capacity of 12,000 kilovolt-ampères, raise the pressure from 11,000 volts to 110,000 volts for transmission purposes. Four high-voltage transmission lines are connected up to the station. Two of these lines go north to Bunnythorpe, some 25 miles away, whilst the other two run south to Khandallah, which is situated at a distance of 63 miles. The sub-station at the latter place supplies the city of Wellington, whilst a sub-station at the former supplies Palmerston North and the surrounding Manawatu district.

The arrangement of the power station is very compact. All the turbines and alternators are housed in a large turbine room, which extends almost the full length of the building. The two banks of transformers, together with the oil storage tanks, are situated in a room having the same length as the turbine room, but of approximately half the width. Between the turbine and transformer rooms space is reserved for the switch and control gear, and the masonry cubicles containing the 11,000-volt apparatus are situated on the main floor level. The control room, which is immediately above the cubicle room, is arranged so that the switchboard operators can gain a clear view of the turbine room. A large storage battery for the supply of current to the control gear and for working certain auxiliaries is also installed on this floor in a separate room at the end of the station.

The high-voltage switchgear is placed partly inside and partly outside the station. The section inside consists of circuit breakers and other apparatus necessary for controlling the 110-kilovolt side of the main transformers and the bus-bar sectionalising

arrangement, whilst the outside section consists of four outgoing feeder equipments, together with the lightning arresters. These four equipments are mounted on the station roof, which has been designed to take the weight. The transmission lines are "dead ended" at points on the building structure, and jumper connections connect the lines to the apparatus on the roof. This arrangement utilises the station site to the best advantage, and avoids the large expense and excavating necessary for levelling a special site on the hillside to accommodate the outdoor apparatus, while it also provides a very convenient "jumping off" point for the overhead lines. In order to permit of interchangeability of the high-voltage switchgear, no distinction has been drawn between indoor and outdoor mounted apparatus, all the parts for the high-voltage equipment being suitable for use inside or outside the station.

A duplicate transmission line connects Khandallah with Bunnythorpe *vid* Masterton, Eketahuna and Woodville, and branches radiate to Dannevirke and Marton. The transmission lines are run in duplicate on Australian hard wood poles, fitted with suspension type insulator units, and a triangular arrangement of the conductors has been adopted. The lines are composed of 19/13 copper cables spaced at 10ft. centres. Between Packakariki and Khandallah, a distance of about twenty miles, steel towers carrying double circuits are to be substituted for two lines with hard wood poles. On this section the line passes over some particularly rough country, where patrolling would be difficult, and the steel tower construction should minimise the risk of breakdown.

An interesting feature of the plant is the provision of automatic gates for controlling the level of the water at the dam. The crest of the structure where the gates are placed is at an elevation of 1238ft. 4½in., but the water level is held up to an elevation of 1250ft. The gates are pivoted above a point slightly below the centre, and the lower portion moves in a chamber in the shape of a quadrant, so as to control the movement of the gates. Narrow syphon spillways are provided, and immediately the water overtops the level of 1250ft. the spilling by means of these syphons increases the pressure on the lower half of the pivoted gates, tending to tilt them towards the horizontal, and as long as the level is maintained at 1250ft. the main panels will tilt over and discharge water over the crest. Should the quantity of water to be dealt with be reduced and the level begin to recede from 1250ft. the pressure tilting the gate over is reduced by the drying up of the syphon spillways, and the gate then tends to tilt back towards the vertical, and holds up the level by reducing the discharge. In this way the level under all conditions of flow is maintained within very close limits.

The illustration—Fig. 6—shows the generators and turbines in the Mangahao power house, whilst Fig. 5 shows the main switchboard. Fig. 4 shows an exterior view of the power-house, and Fig. 7 the outdoor extra high-tension switchgear and transformers mounted on the roof of the power-house. On page 270 we give a series of views relating to the hydraulic work. Fig. 8 shows the Mangahao reservoir partly filled, the top of the grating over the tunnel mouth being just visible. Fig. 9 shows the Mangahao River in flood. Fig. 10 gives a view from below the Mangahao dam showing the large pass tunnel. Fig. 11 is a view of the Mangahao dam with the concrete work nearly completed. Fig. 12 shows a portion of the camp at Mangahao, Fig. 13 is a view of the Arapeti dam storage area, Fig. 14 is a view taken from the top of the Arapeti dam, and showing the storage area, whilst Fig. 15 shows the face of the Arapeti dam.

A considerable part of the electrical plant was supplied by the Metropolitan-Vickers Electrical Company, whilst Boving and Co., Limited, supplied the water turbines. The 110,000-volt transformers for feeding the transmission lines were supplied by Ferranti, Limited, of Hollinwood, and they were described in our issue of October 20th, 1922.

## Switchgear.

A PAPER containing nearly forty illustrations and entitled "The Design of Electrical Plant Control Gear and Connections for Protection against Shock, Fire and Faults," was recently read before the Institution of Electrical Engineers by Mr. H. W. Clothier, of A. Reyrolle and Co., Limited.

In the main the author made an endeavour to collate present practice, and to consider some demands which are in a nebulous stage, including the duplication of components, the changing over of live circuits, the use and effect of reactances, charging resistances and lightning arresters, and the best means of obtaining economy in switchgear construction without loss of safety.

In reviewing known automatic protective systems, stress was laid upon the importance of what the author termed the "stability ratio." In balanced automatic protective systems stability is jeopardised by certain influences, some of which have recently been discovered, and have been brought to light by new conditions of service. They include the unbalancing effect of high-frequency oscillations on main lines, and interference by induction between the main line and the pilot line. Suitable remedies are available and have been applied.

We shall not attempt to do more than touch very briefly upon one or two points in the paper. Needless to say, the author paid considerable attention to metal-clad switchgear. The metal-clad enclosure of all conductors, he explained, reduces switchgear breakdowns, and the metal shell tends to localise disturbance and prevents the arc spreading. The duplication of bus-bars, Mr. Clothier said, was advantageous on certain occasions, as, for example, under the following conditions:—(1) When running up a new or doubtful machine on an independent circuit or test circuit; (2) when making extensions one bar might be made dead at a time; (3) for cleaning purposes; and (4) in the case of switchgear breakdowns. One of the objects of metal-clad switchgear, however, was to eliminate items (3) and (4). The complete enclosure of all insulators avoided cleaning, and if care was taken in the selection of switchgear, the chances of breakdown were very remote.

The operation of changing from one circuit to another, the author went on to explain, was always more or less risky. Many serious accidents and shut-downs had occurred as the result of the faulty opening of bus-bar selector switches of open type switchgear whilst carrying load. In the design of metal-clad power station switchgear, however, care had been taken to remove that danger, and to make it impossible to change circuits over whilst they were carrying load. The hood of the circuit breaker was fitted with two sets of plug sockets, corresponding to the top and bottom bus-bars, and one set of plugs. Access to the change-over plugs could only be obtained by first withdrawing the circuit breaker carriage. The change-over fittings were therefore safe, and it was impossible to change over when the circuit was dealing with load. A device which might be either hand-operated or automatic in action and interlocked with synchronising and auxiliary switches, gave a direct and remote "top" or "bottom" bus-bar indication. Several other schemes designed to overcome the trouble mentioned were described by the author.

The separate phase enclosure in metal-clad switchgear, it was explained, is, as a rule, only adopted where heavy duty and comparatively high voltages combine, and make

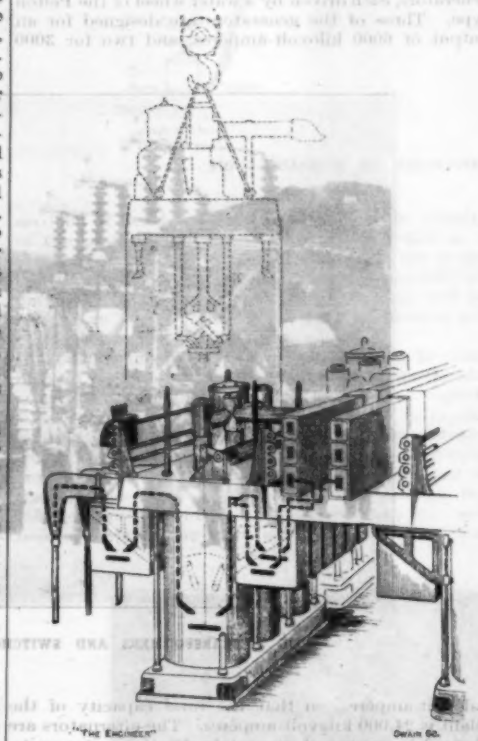



FIG. 1—DIAGRAM SHOWING COMPLETE PHASE SEPARATION

it advisable. These conditions occur in the case of capital stations, and on extra high-voltage networks of large kilovolt-ampère capacity, but experience indicates that the multiphase enclosure of bus-bars, instrument transformers, and connections sealed in compound, is quite sufficient for power stations in which the aggregate full load is below 100,000 kilowatts, or in which the pressure is below 40,000–50,000 volts. The practice in this respect is somewhat analogous to the use of three-core or single-core cables. The likelihood of an internal fault in metal-clad switchgear, Mr. Clothier explained, is remote, but should one occur the arc cannot be long or sustained, because it is confined to the earthed metal in the close vicinity. This, however, is not the case with cellular switchgear, in which there are open conductors separated from earth by large air spaces. In some of the largest stations in the world the phase separation has been carried out to the extent of providing what is virtually a separate building for each phase, but experience has shown that even with this extreme precaution a fault can spread from one phase to another. According to the author, at least one case is on record in which the entire switchgear was destroyed by fire caused and sustained by an arc having a resistance too high to cut out the generators, and there are many cases in which arcs have spread over two or more panels, necessitating a complete shut down of the power station.

An example of complete phase separation with metal-clad switchgear is shown in Fig. 1. The bus-bar chamber is divided into compartments, and earthed metal surrounds each phase. The isolating switches, circuit breaker, current transformer, and single-phase potential transformer, and all the connections down to the cable dividing box are in separate phase enclosures, and the principle may be extended by using single cables for generator and transformer leads.

The author paid considerable attention to circuit breakers, and explained that the enclosure of the circuit breaker was a large factor in determining the breaking capacity. The majority of circuit breaker failures, he said, had arisen as the result of weakness in tanks and top plates. The predominant feature was the relation of the arc energy to the impulse pressure on the walls, and the top and bottom of the oil switch enclosure. In the case of metal-clad gear in ordinary industrial service, the circuit breaker had been more economically and conveniently arranged in one tank, rather than in three separate tanks, and metal divisions inside the tank surrounding three sides of the sparking contacts, for a breaking capacity above 100,000 kilovolt-ampères, eliminated the risks of arcing between phases, in addition to strengthening the tank. Vent pipes, Mr. Clothier explained, could never be large enough to give adequate relief to local pressures established by the arc within the tank. Moreover, open vent pipes

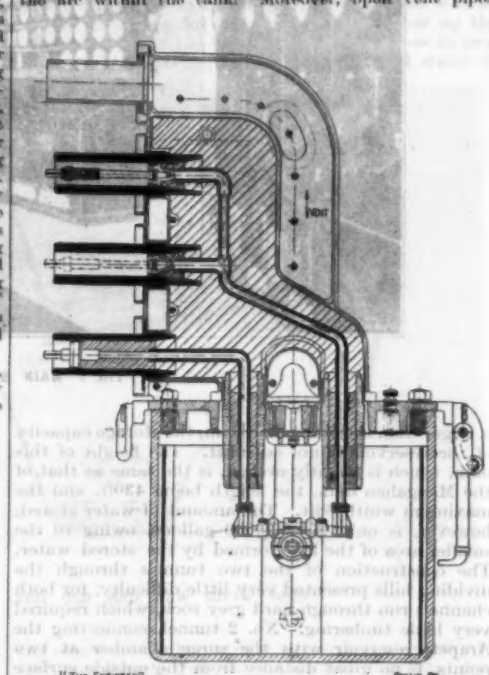



FIG. 2—SECTION OF CIRCUIT BREAKER

threw large quantities of oil. On the other hand, as some outlet was necessary to allow for the escape of the gases and smoke, a baffled vent had been evolved.

Various methods, the author explained, had been proposed to limit the amount of arc energy and the resultant stress in the enclosure, and these methods were reviewed. Dealing with the explosion pot method, the author said that at some time or other the arc or gas explosion might occur outside the pot when the ultimate safeguard would be a strong external enclosure. The simplest construction of current carrying and arcing contacts, the author said, includes one or at the most two breaks, spring loading for increasing the natural acceleration due to gravity and a large volume of oil. The oil volume provided ample clearance for insulation, particularly along the insulating surfaces between the contacts and the top plate, and a good head of oil above the point of separation of the arcing contacts. The whole was enclosed in boiler plate tanks and a steel top plate

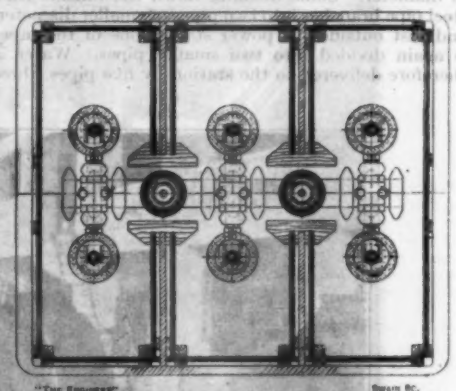



FIG. 3—PLAN OF CIRCUIT BREAKER

was attached, together with correspondingly strong studs or bolts and flame-proof flanges. That construction had been applied to reduce the arc energy to a minimum, and to provide sufficient strength in the enclosure to withstand the impulse pressure.

A typical design of circuit breaker embodying the features advocated is shown in Figs. 2 and 3, the construction having been used on a generating plant of 60,000 kilowatts, with 10 per cent. reactance. The tank is capable of withstanding without permanent distortion a sustained hydraulic pressure of 350 lb. per square inch, which corresponds to an impulse pressure possibly ten times greater.

The introduction of reactance reduces the current, and therefore the destructive mechanical forces on all parts of the system, but it does not, Mr. Clothier argued, necessarily reduce the arc energy with which the circuit breakers have to deal in clearing short circuits from the system. In fact, Mr. Clothier showed that in some cases the stress experienced on the circuit has actually been greater as the result of reactance, notwithstanding the reduced current.

## Railway Matters.

CONSTRUCTION began at the end of February on a network of long-distance electric tramway lines, which are to link up all important points in the Polish coal-mining district. The lines are being constructed by an Anglo-Polish company, with the aid of British capital, and mainly with machinery imported from Great Britain. The system will be opened early in 1926.

THE chairman of the Great Northern (of Ireland) Railway, speaking at that company's annual meeting the other day, said that the Boyne Viaduct, Drogheda, was about to be renewed. He observed: "This structure is of no little historical interest, being the first example in the world of a large span lattice girder bridge. In size it still ranks among the first really large engineering works in Ireland." We would add that the viaduct has a centre span of 265ft., two side spans of 140ft. each, and ten semi-circular approach arches of 60ft. span on the south side and four on the north.

THE chairman of the Great Western stated on February 25th that had the traffic which passed over that system by railway and through the docks last year been carried by the rates in operation on January 1st, 1923, it would have yielded £1,200,000 more in gross receipts. That would indicate the extent by which railway rates and dock charges had been reduced. On the subject of wages, Viscount Churchill further observed that in 1913 all the companies now in the Great Western group paid £8,221,000 in salaries and wages, or 63.59 per cent. of their total expenditure. Last year the total was £21,700,000, or 71.53 per cent.

A DEPUTATION recently waited upon the Minister of Transport to urge the need of greater railway facilities for south-east London. Colonel Wilfrid Ashley, in reply, said that the importance of that vital question had been impressed upon him immediately on taking office. He had already received an influential deputation from the East End of London, and had arranged shortly to receive one from the north-east of London. When he had done so, he proposed to consider the whole question, in conjunction with his Department, and afterwards remit the matter of the measures to be taken to the London Traffic Advisory Committee, for consideration and report.

AT the Wolverton works of the L.M.S. a plant was installed last year by means of which a covered goods wagon could be assembled in an hour and three-quarters; but the Derby works now seem to have "gone one better" by turning out 12-ton merchandise wagons at the rate of one every 25 minutes. In addition to the completion of the actual vehicle, this time allows for a first coat of paint. Vestibule passenger coaches are being assembled at the rate of one every half-hour. In this time, however, the upholstery is not included. By a new and cleverly devised system of jigs, the doors for these carriages are put together in less than a minute each, and careful standardisation enables them to be fitted, without adjustment, into any carriage doorway. For repair work these doors will be readily interchangeable.

IN reply to a question as to automatic train control addressed to him on February 24th, Colonel Wilfrid Ashley said that since the Departmental Committee reported the companies had, as recommended by the Committee, appointed a body of experts to consider the whole question, and he was informed that the matter continued to receive close attention. But, inasmuch as numerous investigations affecting many departments were involved, definite conclusions had not yet been reached. It was not possible to state, as further asked in the question, the number of accidents which were due to the lack of automatic train control, but out of sixteen cases of collision in 1922 and fifteen in 1923, into which inquiries were held, such control would, in the opinion of the inspecting officers, have prevented respectively seven and three.

THE recently issued Board of Trade returns give the value of the railway material exported during the whole of the year 1924. It is as follows, the corresponding figures for 1923 and 1922 being added in brackets:—Locomotives, £1,851,837 (£2,893,626, £5,074,843); rails, £1,624,211 (£2,560,766, £3,445,710); carriages, £1,105,963 (£987,014, £2,020,844); wagons, £3,247,203 (£3,167,374, £3,347,310); wheels and axles, £547,294 (£984,449, £1,194,397); tires and axles, £605,324 (£697,676, £417,077); chairs and metal sleepers, £1,142,687 (£950,552, £2,015,977); miscellaneous permanent way, £1,166,328 (£1,305,375, £1,388,974); total permanent way, £5,306,457 (£6,807,256, £7,655,508); the weight of the rails exported was 174,711 tons (287,534 tons, 253,680 tons), and of the chairs and metal sleepers, 91,160 tons (82,404 tons, 143,911 tons). During the month of December, 1924, locomotives to the value of £31,434 were shipped to South Africa and of £18,415 to India: whilst rails to the value of £60,792 were sent to the Argentine, and of £23,071 to India.

IT is stated that application is being made to the Minister of Transport by the London Electric Railways Company for power to construct a short connecting line at King's Cross between the City and South London Railway and the Piccadilly section of the London Electric Railway, so that the rolling stock of the Hampstead and City lines may also be taken to Acton for overhaul and a further centralisation take place. This, we would remark, is a very unusual way by which to obtain such powers, but it is a means that, under the Railways Construction Facilities Act, has been available since 1864. The Act recited: "And whereas the object aforesaid would be promoted if, when all landowners and other parties beneficially interested are consenting to the making of a railway or the execution of a work, the persons desirous of making or executing the same were enabled to obtain power to do so, on complying with the conditions of a general Act of Parliament without being obliged to procure a special Act." The Board of Trade—now the Ministry of Transport—has to make sure that the necessary consents have been received, and the draft certificate has to be laid before both Houses of Parliament within seven days, and public notice thereof to be given. If either House within six weeks resolves that the certificate should not be made, it shall not be further proceeded with.

## Notes and Memoranda.

TRIAL was recently made in Vienna of a new system of disposing of snow in the streets. The snow was heaped by ploughs and shovelled into large metal basins, which were heated by steam jets. It is said that the scheme was satisfactory, and that the snow was melted at the rate of 1350 cubic feet an hour.

IN order to provide for additional electric power to replace that formerly generated by the Tokyo Municipality, situated at Shibuya, and Shinagawa, both of which were destroyed by the 1923 earthquake, it has been decided to construct one large steam-driven electric power station as soon as a suitable site can be procured. The power generated will be utilised chiefly by the Tokyo street car system, but a certain amount will also be used for lighting service within the city limits.

THE results of a study of low-temperature carbonisation of the Pittsburg and Upper Kittanning coals, made by the American Bureau of Mines in co-operation with the Carnegie Institute of Technology at the Pittsburg experiment station, indicate that the regular Pittsburg bed coal is a good low-temperature coking coal. When carbonised at 550 deg. Cent. in a stationary vertical retort, it will yield 33 to 35 gallons of tar, 3500 cubic feet of 600 B.Th.U. gas, 1400 lb. of 10 per cent. volatile coke, and 6 lb. to 8 lb. of ammonium sulphate per ton.

IT is stated in the *Chemical Trade Journal* that La Société de la Vieille-Montagne, the large Belgian zinc manufacturing concern, is to make large extensions at its Viviez works. At this particular factory extra pure zinc, utilised principally for alloy purposes, and produced by an electrolytic method, is made. Last year some 3000 tons of this pure metal were made, while an output in the neighbourhood of 6000 tons is hoped for during the present year. In two or three years time it is anticipated that the annual output will be about 12,000 tons.

WITH a view to providing for motor ships a type of whistle which will also provide a visible signal, the Sperry Company recently introduced a device which is designed to supply to the usual air-operated whistle, a white, easily visible smoke cloud. A by-pass air pipe is led from the whistle line to a special tank containing the smoke-forming solution, and every blow of the whistle is accompanied by the discharge of a large volume of white smoke. In the case of fog, when sound only without visible evidence of a blow on the whistle is required, an arrangement is fitted whereby the smoke tank can be cut out and the whistle may be operated by air alone.

A LABORATORY for radium research, with special reference to the study of the chemical effects of radium radiations, has been established in Washington under the direction of the chief of the division of mineral technology. This work has hitherto been conducted at the rare and precious metals experiment station at Reno, Nev. Prior to transfer of the radium equipment to Washington, the following reactions produced by alpha radiation were studied:—Decomposition of carbon monoxide; the reaction between carbon monoxide and oxygen; reduction of carbon monoxide by hydrogen; reduction of carbon dioxide by hydrogen; reaction between methane and oxygen; and decomposition of methane.

THE official inquiry into the cause of an explosion of a tar heater at Queen's Ferry disclosed an unusual source of danger. The heater was charged with crude tar and was heated by the vapours coming from a still. Although the heater was well protected by safety devices, it exploded, and a man was killed. It is assumed that during a long idle period some emulsion settled out of the tar in the heater, and that when the apparatus was gradually heated up the comparatively cold emulsion was abruptly brought into contact, by some disturbance, with the hotter tar above, its water content was very quickly evaporated, and the steam was generated at such a rate that the safety valves were inadequate. It is suggested that a circulator would have minimised the danger.

AT the request of the Commission of Gold and Silver Inquiry, of the United States Senate, a study of the possibility of finding new uses for silver has been undertaken by the Bureau of Mines. The purpose of the study is, by the extension of the use of silver into new products and industries, to increase the demand for the metal, and thereby aid the western silver-mining industry, which for some years past has faced unfavourable economic conditions. A progress report of the investigation, submitted to the Commission of Gold and Silver Inquiry, points out the possibilities of increasing the use of sterling silverware. The custom of buying silver articles for permanent use is well established in Europe, but has not been taken up to anywhere near the same extent in America. If the American public could be led to purchase and own as much solid silver tableware as in Great Britain, the market for silver would be greatly stimulated and a better price be obtained. According to the American National Retail Jewellers' Association, 85 per cent. of the volume of silverware sold in America is plated silverware, which requires a comparatively small volume of this basic metal.

THE Pittsburg experiment station of the Bureau of Mines, in co-operation with the American Society of Heating and Ventilating Engineers, is conducting a series of experiments to determine the physiological effects that various atmospheric conditions have on workers in mining and other industries. These tests are conducted in two psychrometric rooms, lined with cork, and equipped with ingenious devices for determining temperature, humidity, and air motion. Experiments demonstrated that in still air the body at rest is unable to compensate for moisture-saturated air at temperatures exceeding 90 deg. Fah. The exhaustion and weakness after exposure to a very high temperature and humidity for a short period are not so severe as those that follow exposure to a moderately high temperature and humidity for a longer period. The pulse rate, rather than the rise in body temperature, apparently determines the extent of the discomfort felt. Men became very uncomfortable when their pulse rate was faster than 135 beats a minute and felt great distress when the pulse exceeded 160. The highest pulse recorded was 184. Individuals differ in respect of loss of weight during exposure to high temperature and humidity.

## Miscellanea.

IN Ottawa, Ontario, Canada, what is thought to be the largest wire-weaving loom in the world is being installed. It is to be capable of weaving wire cloth 258in. wide, the cloth in question to be used in paper-making machines.

FOR the first time since its formation in 1854, the Society of Engineers (Incorporated) has elected a woman member. She is Miss Annette Ashbury, works manager of Atalanta, Limited, and is a member of the Women's Engineering Society. She did excellent service during the war as an engineer.

IT is stated in the *Chemical Trade Journal and Chemical Engineer* that a very large new glass factory is being built between Wingles and Meurchin (Pas-de-Calais). This factory, the productive capacity of which will be from 30–50 per cent. of the total French production, is expected to commence operations about October of this year.

NO fewer than 151,379 private and pleasure cars valued at £23,641,730 were exported from the United States during last year, as compared with only 127,035 vehicles—£19,053,000—in 1923. During the same period the export of American commercial vehicles advanced from 24,859—£3,217,880—to 27,351—£4,033,470—last year. It is interesting to note that the average value of the cars exported increased from roundly £149 to £156, and of the commercial vehicles from just under £130 to approximately £147.

IT is reported that the British Aluminium Company, Limited, has placed a contract with Balfour, Beatty and Co., Limited, for a tunnel 16ft. in diameter under Ben Nevis, to carry the waters of Lochs Treig and Laggan to a new power-house at Fort William. The tunnel will be some 15 miles in length. This project—the contract price for which is over £1,700,000—is part of a scheme, estimated to cost £5,000,000, which will ultimately involve harnessing the river Spey to provide power for the aluminium works to be established at Fort William.

SPEAKING at the annual meeting of the shareholders of the Liverpool Gas Company, the chairman, Mr. H. Wade Deacon, said that the severe competition they had to meet from electrical undertakings in the district became keener each year, but that it was with extreme reluctance that they faced the necessity for an increase in the price of gas. The Government was talking about establishing electricity works all over the country out of public money. The company would have to watch such proceedings very carefully and take steps to safeguard its interests.

THE German coal industry is again threatened with a crisis. Sales have declined owing to the mild winter and competition from lignite and oil. Over 7,500,000 tons, or about a month's production, are lying unsold on the Ruhr. Many miners have been put on short time. The production of coal in the whole Republic in January was 11,928,524 metric tons, against 8,785,393 tons in January, 1924, and of lignite 12,375,441 tons, against 9,553,316 tons. Owing to the stagnation the daily Ruhr production in February was only about 344,000 tons, against 379,000 tons in January.

THE financing of the several new hydraulic engineering schemes approved by the Italian Government, which has hitherto proved difficult, having been arranged, two of the more important projects are to be commenced. In the Province of Veneto, with an area of nearly 9500 square miles, reclamation work, involving an expenditure of 10,000,000 lire, has been started. In the Province of Basilicata, another important reclamation undertaking, to cost 2,000,000 lire, will soon be begun. The total credits granted by the Government for these and other works of the same character during the current year amount to 83,500,000 lire.

IN a note issued by the Telephone Development Association, the importance of the telephone industry is effectively illustrated by a long list of other industries—metallurgical, electrical, tool making, building, chemical, textile, rubber, &c.—the products of which are used in the creation and maintenance of a telephone system, showing that the development of the telephone service would stimulate some 50 industries, and affect every part of the British Empire. To bring Great Britain up in the list of nations arranged according to telephone density from her present position of fourteenth to the level of Norway, the sixth, would require the addition of 1¾ million telephone stations, at a cost of 88 millions sterling.

THE Council of the Institution of Electrical Engineers, being of opinion that there are new provisions in the Wireless Bill, as compared with the Act of 1904, which are likely to prove detrimental to the progress of wireless telegraphy, of radio science generally, and of other electrical matters, has invited the Postmaster-General to defer any immediate further proceedings with the Bill so that the Council may have time to give careful consideration to its provisions, which it considers to be of far-reaching importance, and an opportunity of submitting to him its representations thereon. In view of the urgency of the matter, the Council's letter has been circulated to the members of the House of Commons and the Press. Other bodies, including the Radio Society of Great Britain, are protesting against the passage of the Bill in its present form.

IT is reported from Genoa that the commercial movement at that port has now attained dimensions superior to that of Marseilles, having exceeded during 1924 the movement at that port by 1,207,265 metric tons. The respective freight totals of the two ports were:—Genoa, 5,550,834; and Marseilles, 4,343,569 metric tons. The pronounced advance at Genoa has been due, not only to the enlargement of the port's accommodation, but, in a great measure, to the lowering of tonnage dues and other charges, together with a more economical administration. With the view of again obtaining supremacy, or at least equality, on the Mediterranean, the port authorities of Marseilles have commenced work upon the construction of a new breakwater and reclamation operations, to cost 48,000,000 francs. These and other contemplated improvements should tend to concentrate new dock construction nearer to the original centre of the water front. It is considered that hitherto the building of new docks has been carried out too far north, and therefore inconveniently distant from the heart of the city.

# THE MANGAHAO HYDRO-ELECTRIC POWER SCHEME

(For description see page 266)

FIG. 8—OUTLET END OF MANGAHAO RESERVOIR

FIG. 9—THE MANGAHAO IN FLOOD COMING THROUGH BY-PASS TUNNEL

FIG. 10—VIEW BELOW MANGAHAO DAM SHOWING BY-PASS TUNNEL

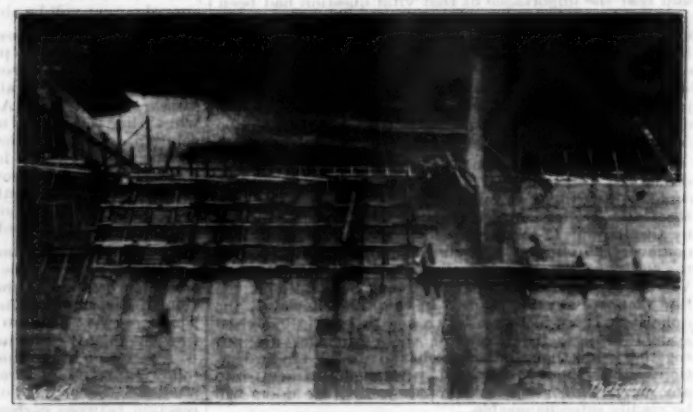


FIG. 11—MANGAHAO DAM CONCRETE WORK NEARLY COMPLETED

FIG. 12—PART OF CAMP AT MANGAHAO DAM

FIG. 13—ARAPETI DAM STORAGE AREA

FIG. 14—ARAPETI STORAGE AREA FROM TOP OF DAM

FIG. 15—ARAPETI DAM NEARLY COMPLETED

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# THE ENGINEER.

*MARCH* 6, 1925.

### Speed and Weight.

INCREASE of speed is amongst the obvious tendencies of engineering. In some cases it is accompanied by a simultaneous increase, and in others by a reduction, of weight. Passenger ships and trains are typical examples of increase of both speed and weight, while in the reciprocating parts of fast-running machinery we have examples of the second type. But increase of weight is always opposed, and hence it follows that in both cases the question of the choice of materials, not only as to general type, but in regard to detailed specifications, is becoming a question of increasing difficulty. Where, thirty years ago, mild structural steel with a tensile strength of rather less than 30 tons per square inch was regarded as high-class material, we look to-day for heat-treated alloy steels whose strength may run to 60, or even 80 tons per square inch. Events move rapidly. When the Mauretania was built so-called "high-tensile" steel was employed for certain parts of the hull, yet the material was of a grade which we should hardly term "high tensile" to-day. Correspondingly, it seems not unlikely that twenty years hence the metals which we still look upon with some little hesitation—our present "high-tensile" alloy steels—will be regarded as ordinary or even obsolescent.

We cannot prevent developments such as this, and no one who has the progress of engineering at heart desires to prevent them; but there are several inconvenient consequences which flow from an evolution of this kind. The older materials—wrought iron and mild steel—are undeniably very much simpler than the new. It is possible, to a large extent, to take them for granted; mechanical and thermal treatment no doubt has important effects upon them, and at times these effects have made themselves felt in engineering practice in an unpleasant manner when they have been too roughly ignored. Burnt or severely over-heated mild steel, or steel which has been locally strained or damaged by unduly severe cold working, has from time to time failed in use. Fortunately, however, no very intimate knowledge of the metallurgy of these materials was needed to enable the manufacturer and user to avoid dangerous conditions. The materials, although by no means foolproof, were proof against most of the ordinary kinds of treatment encountered in well-conducted shops. Unhappily, the newer materials are much more sensitive to treatment and can easily be completely ruined by workshop treatment which, with the older materials, would have been almost or entirely harmless. Let us take, for example, a properly heat-treated part intended for use in a structure or machine. It is found, on assembly, that some quite small alteration is needed which with ordinary mild steel could be simply made—say, by heating the part locally in the forge and then "setting" it with a hammer. The heat-treated alloy steel is apparently quite readily treated in the same way. Like the simpler material, it is readily softened in the fire and "set" as desired, and after cooling it is, apparently, as strong and stiff as ever. But in reality it has suffered damage that could only be remedied by the re-application of proper heat treatment—a treatment which the erecting workshop may be unable to give, possibly from lack of equipment or of knowledge, or of both. At first sight it would seem obvious that careful and intelligent supervision would be adequate to prevent incidents of this nature, and ordinarily it does so. But the temptation to get over a temporary production difficulty by some rough-and-ready and quick expedient is very great, and the risk involved is not realised by those who apply such methods. In actual practice, one meets with numerous cases of minor failure resulting from the ill-treatment of sensitive materials, so that it is well worth while to draw attention to the point.

It is, we fear, useless to argue that materials which are so sensitive to treatment that they can be thus easily damaged are unsuited for widespread practical application. The demands of speed and weight to which we have referred are insistent and are only to be met by the use of especially excellent materials. If, unfortunately, this excellence in the finished product is accompanied by sensitiveness to wrong treatment, we cannot on that account refuse to avail ourselves of the material. If we were to follow such a course the pressure of competition from others who are prepared to face the increased care required would soon compel us to do as they did or to pass out of the business. No doubt it is important for the metallurgist to seek materials as free from dangerous sensitiveness as possible, but a certain degree of sensitiveness is inherent where physical properties have to be adjusted to a high standard. The engineer, on the other hand, is simply forced to adopt such materials by the onward pressure of modern practice, and his only safe course is to acquaint himself thoroughly with the effects of various forms of treatment on the particular materials he employs and then to take every possible precaution against the occurrence of dangerous workshop methods. In this way only can he keep abreast of progress in the race for speed and weight.

### Analogies.

SINCE the introduction of broadcasting many who previously took little interest in scientific affairs have begun to study electricity with the object of discovering, if they can, "how the trick is done." The possibility of listening to speech and music at great distances from the place where the sounds are made and without any connecting link that can be seen, surpasses the most astounding conjuring performance on record, and those of a curious turn of mind are desirous of unravelling the mystery. Whether we are concerned with wireless communication or with electric power engineering, analogies are of great assistance in forming a mental conception of what is happening in and around conductors and in the dielectrics of circuits, provided they are not overstrained. But unfortunately there is sometimes a tendency to carry the analogy too far—a danger of failing to make a clear distinction between fact and fancy and of failure to realise that the actual electrical phenomena may be of an entirely different character from that of the mechanical analogy employed. Professor G. W. O. Howe tells an interesting story about a colleague of his who once undertook to explain to an old lady from Ireland the nature of the mysterious operations taking place at the Transatlantic wireless station at Clifden. He began by pointing out that if one stood on the west coast of Ireland and threw a stone into the sea a wave or ripple would spread out over the surface of the water, and if a large piece of rock were thrown in a very large wave would be produced, and with a little imagination it was possible to conceive a wave travelling right across the Atlantic. Having thus paved the way, as he thought, he gave an elementary lecture on electromagnetic waves and wireless telegraphy. At the conclusion the lady thanked him very much and said that he had made it all very clear, but she had no idea until it had been explained to her that it was necessary to throw rocks into the sea! This story shows that analogies, whilst useful and sometimes essential, are liable to lead to quite erroneous ideas, although it is

unlikely that the majority of people would arrive at such a hopelessly incorrect conclusion as this old lady from Ireland.

The extent to which it is necessary to utilise mechanical analogies depends very largely on the person addressed. To some a mathematical demonstration appeals, whilst by others—many others, we think—a mechanical picture of the process is required. In the education of electrical engineers mechanical analogies serve a very useful purpose, yet they are perhaps not always utilised by teachers to the extent they should be. During the course of his recent presidential address before the Radio Society of Great Britain Sir Oliver Lodge caused no little amusement by referring to the way some students reply, when asked what they mean when they speak of resistance, the answer given being that resistance is E ÷ C. This reply certainly shows that the student has learnt something about Ohm's law, but it does not indicate that he has formed any conception of what resistance really is. Many people now talk learnedly about electrical quantities, such as voltage, current, inductance, and capacity, yet if they were called upon to explain what they mean not a few, we fear, would have some difficulty in doing so. But once it is realised that electromotive force may be compared with mechanical force, resistance with friction, inductance with mass or inertia, and capacity with elasticity, the student or amateur electrician is well on the road to an understanding of what he is really dealing with. Electrical resonance plays a big part in wireless communication, and sometimes in electric power engineering, especially when it breaks down cables. It is quite easy to show by means of a simple equation the electrical conditions under which resonance occurs, but the student will be in a much better position to understand what is really meant by resonance if he is provided with one of the well-known mechanical analogies, such as the boy jumping on a plank in time with the flexural vibration of the plank, or the pendulum analogy which shows that a pendulum bob suspended by a string can be set in strong oscillation by means of feeble blows, provided the impulses are administered at intervals equal to the time period of oscillation of the pendulum. With the aid of analogies and models the most important parts of alternating current theory can be mastered with no more mathematical knowledge than is involved in the handling of simple equations and right-angled triangles. No one has done more to encourage the use of analogies in the teaching of electrical engineering than Dr. Drysdale, who, although in no way antagonistic towards mathematics, believes that mathematical explanations should not be employed if they can be avoided. Years ago the study of alternating currents was beyond the average engineer, but not so in these days. Thanks to Dr. Drysdale and others who have devised mechanical models and similar arrangements, it is now possible for almost anyone of ordinary intelligence to get some sort of an idea of what is going on in alternating-current circuits.

But, of course, there are good, bad and indifferent mechanical analogies. To explain the action of the oscillating thermionic valve, for instance, the steam engine is sometimes utilised, the steam being compared with the electrons emitted by the filament, the valve grid with the slide valve, and the external plate current with the motions of the piston. Apart from the fact that an oscillating valve circuit has no resemblance whatever to the steam engine, the analogy is imperfect. A better one from every point of view is that provided by a telephone receiver, microphone transmitter, and a couple of dry cells, all connected in series and with the diaphragms of the transmitter and receiver facing one another and in close proximity. An arrangement of this kind can be made to emit a continuous sound for reasons which are pretty obvious, and it is also clear that the power which keeps the arrangement in operation must come from the battery. Once this principle has been grasped it is not difficult to see how the coupled circuits of a valve react on each other and set up oscillations in the plate circuit in accordance with the inductance and capacity of the circuit. Mr. R. C. Clinker, of the British Thomson-Houston Company, has, however, devised a very ingenious dynamic model of a valve and oscillating circuit, which has perhaps not received all the attention it deserves. When he described it in a paper read at a meeting of the Wireless Section of the Institution of Electrical Engineers only two members took part in the discussion, one being a gentleman from Cambridge, who very naturally thought that the action of the oscillating valve could only be explained mathematically. Nevertheless, there are many, we think, who would prefer to use the model. The ability to invent such arrangements is, in our opinion, a great gift, which, however, may prove of far greater value to the rising generation of electrical engineers than to the inventor himself.

## Literature.

*The History of Aeronautics in Great Britain.* By J. E. Hodgson. Oxford University Press.

In the preparation of this history, Mr. Hodgson has limited himself to the work of aeronauts in Great Britain, but not necessarily British aeronauts, and has elected not to carry it beyond what he rather vaguely calls the latter half of the nineteenth century. As a result relatively little of the preliminary work which led up to the success of the Brothers Wright and the coming of the aeroplane is dealt with, though, of course, Henson (1843) and Stingfellow (1848–68) are included. On the whole, however, Mr. Hodgson has but little to say concerning mechanical flight, and by far the greater part of his large and handsome book is devoted to ballooning.

Mr. Hodgson has brought to his task not only an extensive knowledge of the literature of aeronautics, but of literature in general, with the result that he has been able to give to his book a very acceptable literary flavour. It is indeed a volume for the general reader rather than for the expert in aeronautics, but its principal appeal will be to the collector of books, papers, cartoons, lampoons, squibs, broadsheets, newspapers *et hoc genus omnes* associated with man's conquest over the air. When we see much of the material of this kind thus collected we are astonished by the position that aeronautics has taken in human thought since very early times. The history is one indeed of tragedy, but a deal of comedy is to be found in it, as anyone who will turn to Mr. Hodgson's ninth chapter, which treats with "The Balloon in Literature, Caricature and Fashion," may satisfy himself in a few minutes.

In the history of ballooning the fact which cannot fail to attract the attention of the reader is the theatrical nature of all the early ascents. They were proclaimed by handbills, they took place from enclosures surrounded with grandstands, they were accompanied by the playing of bands and the babble of fashion, and the cars in which the intrepid aeronauts took their places were elaborate productions of the stage carpenter. Moreover, as if each nation endeavoured to stake out its own claims in the air, the aeronauts carried into the sky with them national flags which they unfurled to the loud acclamations of the spectators. It cannot be said that aeronautics has differed from other great developments of means of communication in its early dependence upon popular demonstrations. Steamships, railways, motor cars all owe something to that kind of advertisement, but with the exception of the last named it may, we think be safely said, that the balloon has always depended to a greater degree on spectacular displays than either of the greater forms of transport. Thus we find it provided with a copious popular literature and an astonishing number of illustrations of a varied kind. Many of these illustrations are reproduced in Mr. Hodgson's volume, a good many by the three-colour process, and they add not a little to the charm of a fascinating book.

Whilst the balloon was merely an aerostat subject to the will of the winds, it was natural that it should remain a prodigy for crowds to gape at, and for the pen of the lampooner and the pencil of the cartoonist. Despits its danger and its scientific potentialities it was difficult to take ballooning quite seriously. But it was recognised at a very early date in its history that unless means of navigating it could be discovered it could never be regarded as a means of transport.

"To Montgolfier the Invention's due,
Unfinished as it lies,
But his will be the Glory who
Direction's art supplies."

Hence inventors tried their hands at its improvement, yet with no success, for the ignorance brought to bear on the subject was colossal. Men took the balloon to be akin to the ship, and attempted to sail it or to propel it by oars which were about as effective as a pair of quill pens reversed, or again, to propel it with wings or haul it by a team of trained eagles, as in Mackintosh's Zephyr! It is not until we reach 1852 that a real step towards the dirigible balloon is seen. In that year Henry Giffard, famous amongst engineers for the steam injector, actually propelled a balloon with a 3 horse-power steam engine. But as Mr. Hodgson rightly observes, it is unfair to overlook the work of earlier inventors—Samuel Hoole in 1785, Pauly and Egg in 1816, Edgeworth in the same year, and Sir George Cayley. To the last named our author does the justice which has been so long withheld. Cayley was years before his time, and he was possibly the first who clearly recognised the principles of aerial navigation and designed veritable airships. One may say of him as one might say later of Henson, that nothing but the absence of a light engine stopped them from anticipating Zeppelin and the Wrights. Cayley was born in 1773, and he retained his interest in aeronautics till he had attained old age. Throughout he was a confirmed believer in man's conquest of the air. He understood in fair degree the principles of air propulsion, and had grasped the necessity of strengthening airships by suitable skeletons. Mr. Hodgson is of necessity only able to give a few pages to him in this work, but to the Newcomen Society he recently contributed a paper in which Cayley's position in the progress of aerial navigation is very clearly defined.

To the evolution of mechanical flight our author devotes a good many pages, but taking it in broad and large his volume is a history of ballooning. He does not touch that part of mechanical flight which is not set history, but only a record of technical progress. The selection of a period which put such a limit to his task was a wise one, for the Press has turned out already more than enough works on the aeroplane, and the subject has not that fascination for the man of literary tastes, for the collector, and for the antiquary that ballooning has.

We believe that this volume represents the first serious attempt to present a complete history of aeronautics in Great Britain up till about fifty years ago, and readers may congratulate themselves that the work was undertaken by one who has such an intimate knowledge of the subject and such good literary taste as Mr. Hodgson.

*History of the Portland Cement Industry in the United States.* By Robert W. Lesley, in co-operation with John B. Lober and George S. Bartlett. Chicago, Ill.: The International Trade Press, Inc., 53, West Jackson-boulevard. Price 3.5 dols.

This is a book which, we think, will be read, not only by those who are identified in some way or the other with Portland cement, but by others whose interest is purely in history and in the development of commercial undertakings, and even, we venture to think, by still others who like a good tale well and clearly told. Furthermore, those readers will not, we think, be confined entirely to the United States; there will be readers in other parts of the world as well. The authors of the book are eminently qualified to carry out the task of producing it. Mr. Lesley is a veteran pioneer in the industry; he has been in it practically since it was started in his country, and he was the first President of the United States Portland Cement Association, a Past-Vice-president of the American Society for Testing Materials, besides being a member of many learned societies. Mr. Lober was second President of the Portland Cement Association and is President of the Vulcanite Portland Cement Company of Philadelphia; and Mr. Bartlett is connected with the Universal Portland Cement Company of Chicago.

Astonishing as it may seem, having regard to the development there has been, the history of the Portland cement industry in the United States does not go back forty years. There had been importations of the material from this country as early as 1865. Up to 1868 the quantity imported had been insignificant, and in 1871 there was quite a little difficulty in getting rid in New York of a consignment of 500 barrels put on board ship in London as a fill-up cargo. During the first half of the decade 1870–80 the bulk of the Portland cement imported was of English manufacture, though a little was sent from France. In 1876 or 77 the German product began to appear, and afterwards the Belgian. It was during the decade 1890–1900 that it became evident that the imported material would soon be supplanted by cement made in the country. The story of the phenomenal progress made since that time is related in the book before us. In the last quarter of a century production has increased from 10,000,000 barrels a year to nearly 150,000,000 a year. "The business," says Mr. Floyd. W. Parsons, himself no mean authority on the subject, in a Foreword to the volume, "has been developed in a comparatively short time, from a more or less disorganised national enterprise, into a modern industrial undertaking that even in progressive America is regarded as a model in the field of sound, scientific research, effective educational work, and vigorous salesmanship, but all that has been accomplished is but a preliminary to the great work that is coming."

That there is justification for the last few words of that quotation seems clear evidence in the book. In 1922 there were produced in the United States 114,789,984 barrels of cement. The next year the production had jumped to 137,460,238, and though no actual figures are given it is intimated that there have been considerable increases since then. It is interesting in this connection to learn that whereas in 1922 there were in operation in the United States 590 kilns—75.7 per cent. of the total—fired with coal alone, 70—10.5 per cent. of the total—fired with coal and oil or coal and gas, 85—11.1 per cent. of the total—fired with oil alone, and 15—2.7 per cent. of the total—fired with coal, oil and gas, or with natural gas, the numbers in 1923 were:—641 kilns—78.7 per cent. of the total—fired with coal alone, 33—5.9 per cent. of the total—fired with coal and oil or oil and gas, 95—11.9 per cent. of the total—fired with oil alone, and 24—or 3.5 per cent. of the total—fired with coal, oil and gas, or with natural gas. It is evident, therefore, that coal used as a fuel

by itself is more than holding its own in the manufacture of Portland cement in the United States, though the use of oil appears to be on the increase.

In addition to the main subject of the book, which is treated painstakingly and with the accompaniment of much detail and many statistics, the authors discuss at some length the question of the actual inventor of Portland cement, and the early history of the material. Furthermore, there is a good deal said about other commutitious materials, such as natural cement, Puzzuolana, slag cement, iron cement, &c., and descriptions are given of some of the great works which have been carried out in the United States with Portland and other cements.

## SHORT NOTICES.

*The Hodsock Ballistic Tables for Rifles.* By F. W. Jones, with an introduction by Lieutenant-Colonel H. Mellish, C.B., V.D., and an Appendix on the Ballastic Pendulum, by Colonel Lord Cottesloe, V.D. London: Edward Arnold and Co. 1925. Price 10s. 6d. net.—The author explains in his preface that the object which he had in writing this book, and compiling the new ballistic tables which it contains, was to provide riflemen and sportsmen with means by which they might be able to solve their various problems with greater facility and accuracy than has hitherto been possible. The tables have been compiled with the aid of the Metford-Cottesloe Ballistic Pendulum, which, as the title shows, is described by Lord Cottesloe, but what the title does not say is that the description, which is fully illustrated, is most clear and explanatory. Mr. Jones confesses that, prior to 1922, he was unable to believe that this "old type of velocimeter"—the principle was actually introduced in 1740—could compare favourably with the modern chronograph, but that he became completely converted as to the great usefulness of that development known by the name of the "Metford-Cottesloe." Velocity tests made during trials, both by chronograph and the Pendulum gave results, both as regards regularity and average values, which were practically identical, and he adds:—"From that moment I was convinced that the results that had been obtained with the Ballistic Pendulum would provide data for the compilation of suitable ballistic tables for small arms and thus fill up the gap which had long existed." The book describes how the results which led to the compilation of the tables were arrived at, and to those interested in this little known subject should prove of considerable value.

*Rice, its Cultivation and Preparation.* By Charles E Douglas, M. Inst. Mech. E. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 3s. net.—This little handbook, which runs to some 140 octavo pages, forms one of Pitman's "Common Commodities and Industries" series, and deals in an enlightening manner with a subject which comparatively few people in this country know anything about, though, on the other hand, there must be few, indeed, who have not seen and tasted the cereal itself. It is divided into fourteen chapters, the first five of which are concerned with the history of the subject; the botanical and physical characteristics of the grain, its production, distribution and cultivation. Then there are chapters on weeding, harvesting and threshing; transport and supply; and native preparation of the rice for food. Then follow three chapters on Mechanical Milling, &c., power plant and auxiliary services, and buildings, ventilation, lighting. Finally, the "enemies of rice and the methods of exterminating them," and "Rice as a food, and utilisation of By-products" are discussed. In the latter chapter we find the following. "A good rice pudding is a delightful dish, but a badly cooked one is only fit for transmission to the farmyard." Most people, we think, will agree with the author in this dictum. The book is well printed and interestingly written.

*The Principles of Machine Design.* By R. F. McKay. London: Edward Arnold and Co. Price 18s. net.—This volume, while it will no doubt be found an admirable text-book for students, will, we think, be a valuable addition to many a full-grown engineer's library. It has a flavour distinct from the ordinary text-book of machine design, of which there are already almost too many. The range of subjects covered is wide, but Mr. McKay has shown excellent discrimination in his choice of particular examples for detailed discussion. Practice rather than theory is his guiding idea, and we feel certain that many practical engineers will derive benefit from the volume. Incidentally, those students who adopt it should, through its agency, learn the important lesson that in the workshop theoretical considerations have nearly always to be modified and adapted to practical requirements. After discussing the testing and properties of the materials of construction, the author gives us an important chapter on the utility of the data of mechanical tests in design. Thereafter he discusses various forms of connections and joints, the transmission of rotary motion, lubrication and bearings, plain ball and roller. The work ends with a useful chapter on alignment charts.

*La Soudure Electrique à l'Arc Métallique.* By S. Frimandeau. Paris: Gauthier-Villars et Cie., Quai des Grands-Augustins, 55. Price 2f. 50c.—This is a small book which seeks to cover a great deal of ground in quite a small compass. After briefly discussing arc welding in abstract, it proceeds to give a comparison of the two types of electrodes—Kjellberg and Strohmenger (Quasi arc)—which it says are those most commonly used in France. It then goes on to compare the losses occurring in arc welding when using different voltages, and passes on to review various types of machines with special windings. Such subjects as:—(*a*) The *rôle* of the coatings of electrodes; (*b*) the influence on welds of the strength of the current and the length of arc; and (*c*) the density of current in electrodes are then dealt with. Finally, there are chapters on automatic welding machines, the welding of cast iron, and the methods employed for examining welds for soundness.

*The History of Munitions Supply in Canada.* By David Carnegie. London: Longmans, Green and Co. 1925. 18s. net.—A fascinating book which describes in great detail the efforts made in Canada to help in supplying the munitions required by the Allies during the war. Colonel Carnegie had personal association with the work during the whole period of operations, and gives his readers an insight into all phases of the scheme for supplying shells, aeroplanes, ships and explosives from the beginning right up to the Armistice. Much of the subject matter is naturally of an administrative character, but considerable detail of a technical nature is given. Some idea of the extent to which the manufacturing capacity of Canada was enlarged for the purpose of producing munitions, may be gathered from the fact that the output of steel ingots rose from approximately 1,000,000 tons to 1,250,000 tons per annum.

*The Slide Rule.* By A. W. Price. Birmingham: Cornish Brothers. 3s. 6d. net. 1925.—An interesting little book explaining the principle and origin of the ordinary slide rule. Out of some fifty pages the greater part is devoted to instructions for making special calculations at one setting of the rule; for instance, for finding the largest scantling which can be sawn from a round log or the length of bar which can be rolled from a given billet. These instructions would, however, be more valuable if the reasons for the settings were given, so that they could be used as guides in devising other arrangements. The book is confined to the ordinary straight slide rule, and no reference is made to special forms.

*Chemical Colouring of Metals.* By S. Field and S. B. Bonney. London: Chapman and Hall. 10s. 6d. net. 1925.—This book is of the workshop receipts type, and gives detailed instructions for producing all kinds of colour effects on the surface of various metals, by chemical and electrolytic methods. There is also a preliminary section dealing with the principles of chemistry and the action of air on metals. It should prove a very useful book in any workshop or foundry where artistic work is produced, and, to a lesser extent, in engineering factories making high-class tools, fire-arms, &c.

## BOOKS RECEIVED.

*The Electrical Trades Directory and Handbook.* London: Benn Brothers, Limited, 8, Bonverie-street, E.C. 4. Price 25s. net.

*A Danger Spot in Europe.* By Sir Robert Donald. London: Leonard Parsons, Limited, 24, Devonshire-street, W.C. 1. Price 3s. 6d. net.

*Locomotive Running Shed Management.* By W. Paterson. London: Charles Griffin and Co., Limited, Exeter-street, W.C. 2. Price 15s. net.

*The Theory and Design of Structures.* By E. S. Andrews. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 13s. 6d. net.

*Notes and Data on Railway Engineering.* By Frank Reeves. London: Charles Griffin and Co., Limited, Exeter-street, W.C. 2. Price 15s. net.

*Stevens' Elements of Mercantile Law.* Seventh Edition. By H. Jacobs. London: Butterworth and Co., Bell-yard, Temple Bar, W.C. 2. Price 10s. 6d. net.

*The History of the Telephone in the United Kingdom.* By F. G. C. Baldwin. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 42s. net.

*Tables for Reinforced Concrete Floors and Roofs.* By R. Travers Morgan. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 10s. 6d. net.

## Society of Glass Technology.

A MEETING of the Society of Glass Technology was held in the Applied Science Department, The University, St. George's-square, Sheffield, on Wednesday, February 18th. The meeting was devoted to a consideration of the use of Sillimanite in the glass industry, two papers being presented, the first being entitled "A Study of Sillimanite for the Purpose of the Preparation of Refractory Materials," by Mr. A. Cousen and Professor W. E. S. Turner.

The authors observed that recent developments in the glass industry had emphasised the need for good refractory materials, and although much had been done to improve and render more uniform the fire-clays now employed, it was of importance to examine other material likely to give better results. The authors had made a study of sillimanite, and the effect of variation of grain size and of the use of varying types, and proportions of bonding agent were dealt with. The most plastic mixtures, and those giving on fire-clay the most stable and resistant pots were obtained by using sillimanite wholly or largely in the fine condition, in which the bulk of the material passed through a 100-mesh to the inch sieve. With ball clay as a bonding material, good results were found when a proportion of 15 to 30 per cent. of bond was employed. The porosity of hand-moulded specimens was inversely proportional to the amount of bonding agent used, and with the addition of 30 per cent. of ball clay reached as low as 22 per cent. Actual melting tests with soda-lime, potash lead and fluoride opal batches gave glasses superior in colour to, and having a lower iron oxide content than, those melted in good fire-clay pots. Test slabs, both with 15 and 30 per cent. of bond, withstood a larger breaking load than fire-clay slabs after firing at 1000 deg. to 1400 deg., but after heating to 100 deg. or 800 deg., the clay slabs gave superior results. Stourbridge clay gave a less plastic mixture, which gave on firing to 1400 deg. a more porous texture than equivalent mixtures in which ball clay was used. The Stourbridge clay mixture, however, gave promise of producing quite good results when moulded into shape under pressure. Bentonite, a hydrated silicate of aluminium of variable composition, although giving the most plastic mixtures, proved unsatisfactory in practice, and the results obtained did not justify its employment as a bonding agent.

The second paper was entitled "Some Notes on the Use of Sillimanite as a Glass Works Refractory," by Messrs. F. G. Clark and W. J. Rees; it was illustrated by lantern slides and by numerous specimens. The authors explained that for many years manufacturers had been looking for a refractory material which would not only stand the higher temperatures at which in recent years furnaces had been worked, but also withstand the action of melting batch and molten glass upon it at such high temperatures. Tests under commercial conditions showed that molten glass had very little action on articles made of sillimanite, and should have very little effect on sieges made of this material. Bricks of various sizes and thicknesses had also been made of a sillimanite mixture, and used for filling up the exit flues of furnaces when they had worn too big. It was found that these bricks stood the heat perfectly. The mixture was also used in a damp state for repairing the bad places between the pillars and springers in an old furnace, with excellent results. The best results had been obtained with sillimanite bonded with from 10 to 25 per cent. of ball clay. A covered pot had been made from 25 per cent. ball clay mixture soaked for four weeks before use. This pot was 43in. high, and took fifteen days to make. Its cost was greater than that of the ordinary fire-clay pot, but longer life in the furnace and freedom from pot stones would compensate for this. The material was also recommended for rings floating in the glass and for bottoms of tank furnaces. Its thermal conductivity was higher than that of fire-clay. The authors expressed the opinion that sillimanite was the best refractory material yet known for use in the hottest part of any glass furnace, either in contact or out of contact with glass.

## International Conference on Extra-High Tension Electric Systems.

THE third Session of the International Conference on large extra-high tension electric systems—"Conférence Internationale des Grands Réseaux Electriques à très haute Tension"—will be held in Paris from June 10th to 25th next.

The first Session of this Conference was held in November, 1921, and was attended by fifty-six members, representing twelve countries. At the second Session, which was held in December, 1923, twenty countries were represented, and one hundred and forty-two members were present, not including the French. The object of the Conference is to study all questions relating to the production, transmission and distribution of electricity, such study being confined to large stations and high-tension systems only. The work of the Conference is divided into three sections:—

(1) POWER PRODUCTION: Construction of large central power stations and their equipment, alternators, transformers, switchgear, open-air stations, sub-stations, high-tension apparatus, &c.

(2) TRANSMISSION SYSTEMS: Calculations for and construction of towers—steel, reinforced concrete or wood—foundation anchorages, reinforcement of towers, apparatus for attaching conductors, insulators—construction and testing—overhead conductors and underground cables, comparative merits of aluminium and copper in connection with electrical apparatus, influence of inclement weather and climatic conditions, regulations in connection with line construction, State inspection, &c.

(3) OPERATION: Working of central power stations, parallel operation of central stations and systems, safety precautions and inspection of lines, wearing out and inspection of insulators, protection against excess current and excess voltage, relays, telephonic communication between central stations, lightning arresters, State inspection, &c.

At the forthcoming Session of the Conference, the following matters are to be specially dealt with:—

(1) Communication by wireless telegraphy between central stations;

(2) Disturbing influences of high-tension lines on telegraph and telephone wires;

(3) Result of the examination of questions relating to the earthing of the neutral;

(4) Technical specifications for the supply of oil for use in transformers and circuit breakers;

(5) The standardisation of voltages;

(6) Accidents in central stations or on transmission lines;

(7) International regulations for the installation of lines for the transmission of electrical energy at high pressure;

(8) The protection of towers against rust;

(9) The standardisation of test voltages for insulators, apparatus, machines and transformers;

(10) The technical requirements to be inserted in the specifications for the supply of high-tension cables, especially in so far as they concern the methods of measuring di-electric losses;

(11) What influence the nature of the soil has on the behaviour of strain insulators and suspension insulators;

(12) The regulation of power systems operated in parallel when one of them delivers amounts of energy, agreed upon in advance, to all others, and not only to one of them;

(13) Improvement of cos $\varphi$: solutions adopted, and results of experiments made;

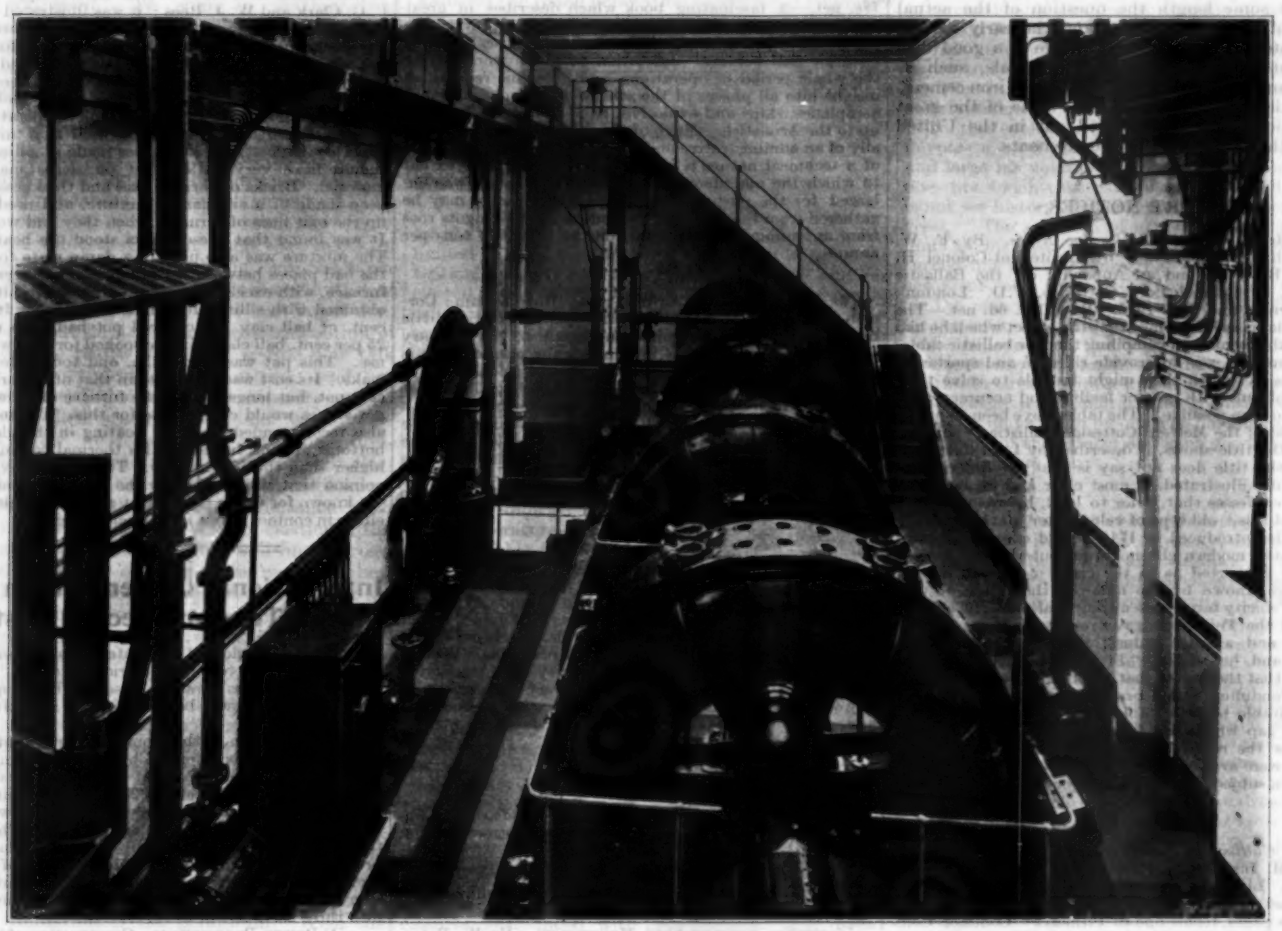
(14) The joining up of power systems of different frequencies;

(15) The working of large steam turbo-alternators, as compared with that of large water turbo-alternators. Statistics of breakdowns.

The languages used at the Conference, both for written reports and verbal discussions, are French and English. The permanent address of the Secrétariat Général of the Conference is: à l'Union des Syndicats de l'Electricité, 25, Boulevard Malesherbes, Paris, from which further particulars may be obtained.

# CLYDE NAVIGATION TRUST—GRAVING DOCK NO. 3 PUMP HOUSE

WALTER BRIDGES AND CO., WESTMINSTER, ENGINEERS



## New Dock Equipment on the Clyde.

No. II.*

### No. 3 Graving Dock Pumps.

Drawings showing the arrangement of the new plant for dewatering Graving Dock No. 3 are given in Fig. 6. The arrangements differ considerably from those for Dock No. 1. In the first place the pumps are considerably bigger, and there are only two of them. Then, again, their shafts are horizontal and the motors which drive them are worked off the high tension 6600-volt 25-cycle three-phase Corporation supply. An illustration of one of the pumps is given in Fig. 5 and an interior view of the pump-house above. The two pumps were each specified to be capable of delivering a mean quantity of 60,000 gallons of water per minute when actually engaged in pumping out the dock, which, the two of them, had to empty in two hours. Two pumps each delivering 60,000 gallons of water per minute working for two hours would discharge in that time 14,400,000 gallons, or some 650,000 gallons more than the ordinary contents of the dock. During the official test 14,970,000 gallons were actually pumped out of the dock in 87 minutes, the same time, curiously enough, that it took to empty Dock No. 1. Supposing that both of the two large pumps were doing the same amount of work, each delivered 7,485,000 gallons in the 87 working minutes, which represents a discharge of over 86,000 gallons per minute, or more than 26,000 gallons per minute in excess of the specified quantity. This overload was, proportionally, considerably greater than that put upon the smaller vertical spindle pumps in pump house No. 1, but apparently both pumps and motors responded to the call, and the same remark regarding the temperature rise in the motors in No. 1 pump house applies to those in No. 3 house. It was within the limits specified for normal power working. In spite of the overloading, too, the remarkable maximum efficiency of 75½ per cent. was obtained, the guaranteed overall efficiency having been 70½ per cent. The average mean overall efficiency over the whole period of pumping out the dock was 59½ per cent. The total number of units consumed in pumping out the 14,970,000 gallons was 1625, which represents an average of 9212 gallons pumped per unit of energy consumed. The static head pumped against varied from zero to 27.25ft.

When this test was carried out there happened to be an exceptionally high tide and the maximum static head pumped against was in excess of the specified figure. The latter was 26ft. 6in., *i.e.*, the height from the level of the sill at the entrance, which was taken as the datum, and the average maximum level of high-water spring tides. The level reached by the tide on the occasion in question was 27ft. 3in. above datum.

These results may be regarded as being very satisfactory, and they are all the more so since the pumps had to be designed to fit pre-existing inlets and outlets, the old bolts and nuts, even, having to be utilised in making the joints. Generally speaking, the same stipulations as were made with the vertical pumps were made concerning the pumps for No. 3 dock, and need not be re-enumerated.

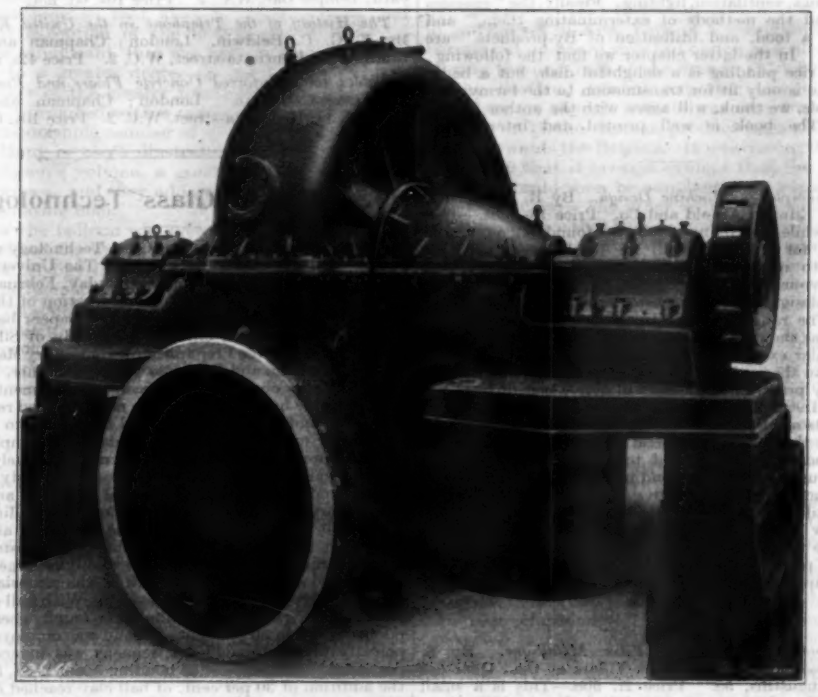


FIG. 5—DEWATERING PUMP FOR GRAVING DOCK NO. 3

The pump cases are in two pieces bolted on the horizontal centre line and have removable centres for examination of the impellers and shafts without disturbing the suction and delivery pipes. The bearings are ring lubricated, and water-sealing chambers and sealing water pipes are fitted to the front and rear stuffing-boxes. These stuffing-boxes have special sealing glands which prevent any grit or matter held in suspension in the water from getting into the bushes or the packing.

The pumps are further fitted with special renewable steel cut-waters or bridges. These bridges are capable of being withdrawn from the pumps through special hand-hole covers provided in the casings. The cut-waters in centrifugal dock pumps are liable to damage by wood and other materials floating through from

* No. I. appeared February 27th.

the docks—hence the importance of making provision for their easy replacement without having to dismantle the pumps. For the same reason it was specified that the impellers, which are cast in Edgar Allen steel, should also be provided with renewable rings on the hubs. The shafts are coupled direct through flexible couplings of the "Zodel-Voith" belt lacing type to the motors to allow of independent wear and alignment of the bearings and also of independent end play; in other words, the shafts are "floating."

The motors are of the induction type with wound rotors and fourteen poles. They operate with 6600-volt three-phase 25-cycle current applied to the stators, the rotors, which are of the bar type, being wound for 600 volts. The pumps, as in the case of Dock No. 1, are started and stopped by means of "Igranic" automatic control gear for the rotors, and automatic "Ironclad" "Reyrolle" draw-out switch panel gear for controlling the high-tension supply to the stators. The high-tension 6600-volt stator automatic switchgear is of the solenoid operated "Reyrolle" solid "Ironclad" type. The switchgears are provided with cast iron potential transformer chambers, and dividing boxes for the incoming and outgoing cables. The operating switches are of the three-phase "Ironclad" oil break type, designed for 6600 volts and of 400 amperes capacity. They are provided with interlocking mechanism and charging resistances.

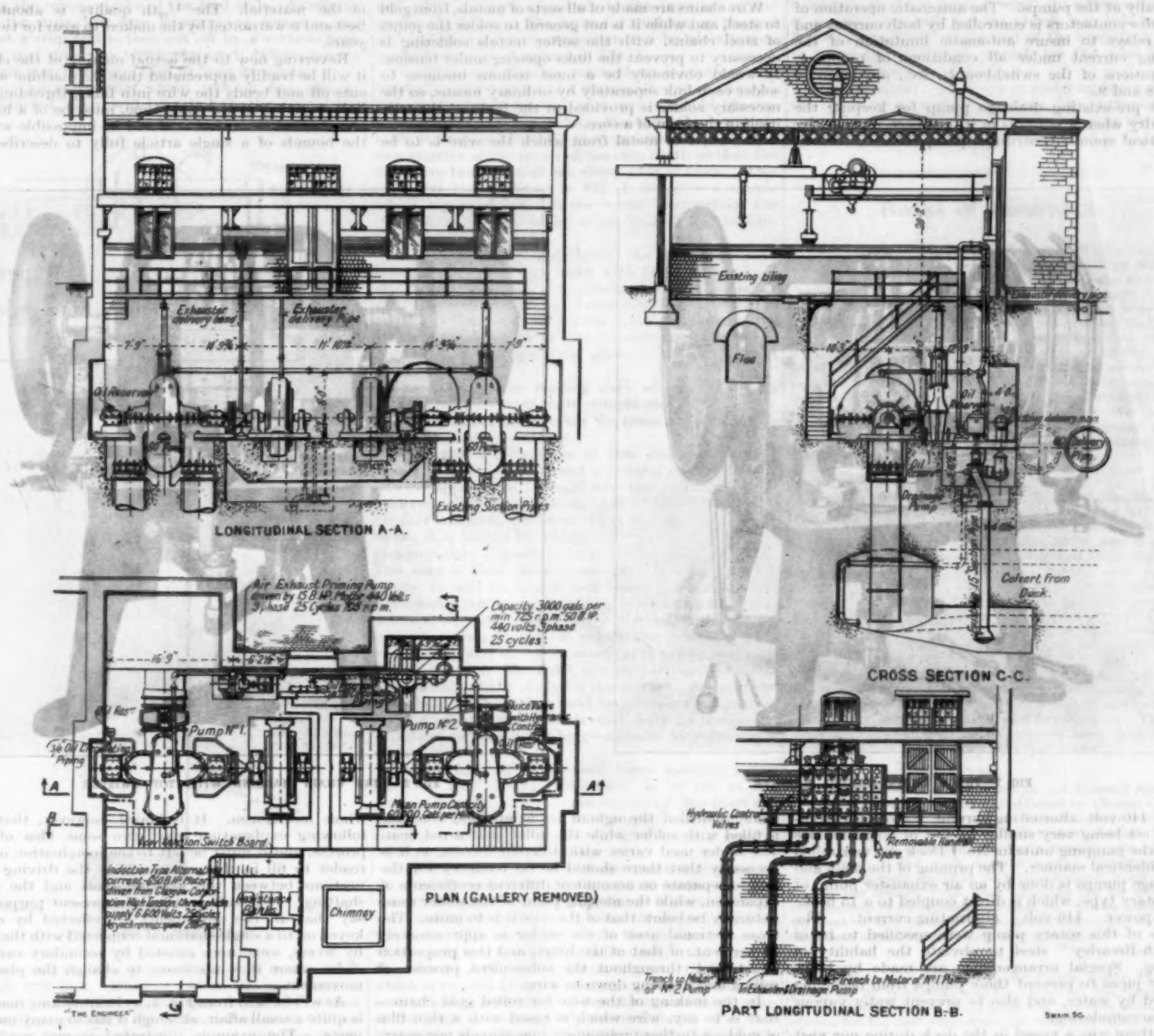



FIG. 6—SECTIONS AND PLAN OF NO. 3 GRAVING DOCK DEWATERING PUMP HOUSE

The rotor control gear and the low-tension main switchboard were supplied by the Igranic Electric Company, Limited. The rotor control gear, which is of the self-acting type, comprises a series of double-pole magnetically-operated clapper switches for controlling various sections of the rotor starting resistances equally in each of the three phases, the resistances being arranged in protecting frames immediately behind the switchboard. This gear is mag-

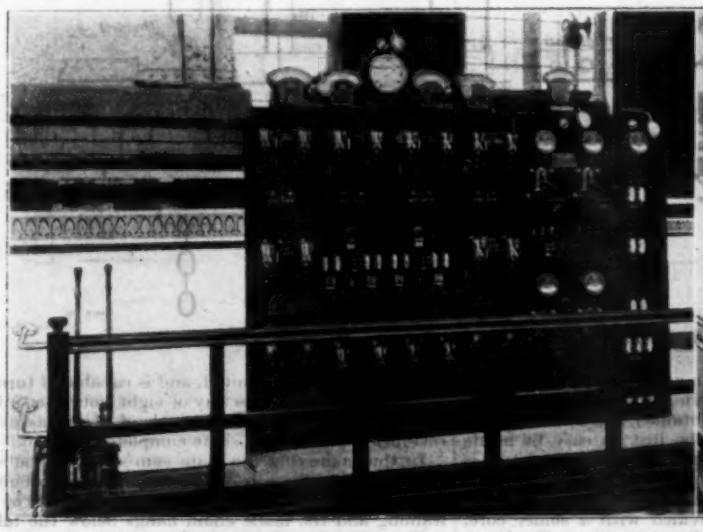


FIG. 7—MAIN SWITCHBOARD

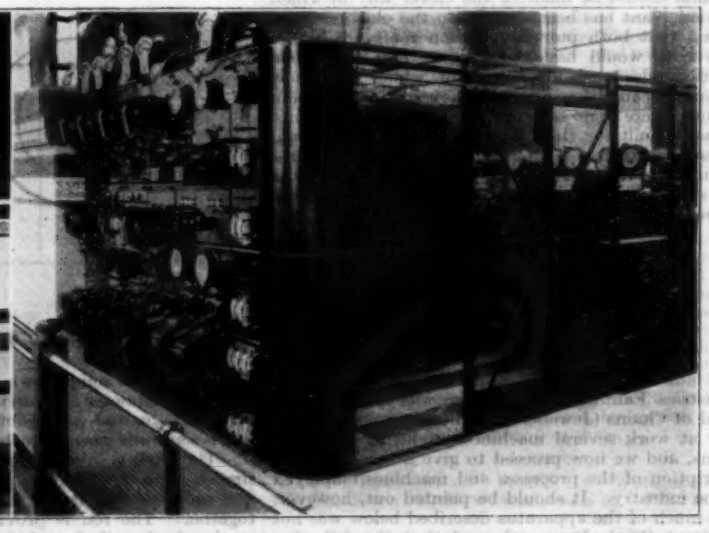


FIG. 8—CONTACTOR PANELS AND HIGH TENSION SWITCHGEAR

netically operated by relays which are energised automatically by the closing of the high-tension "Reyrolle" solenoid-operated stator switches. The operation of starting is effected by push buttons which are provided on the main switchboard as well as locally at the pumps. The automatic operation of the rotor contactors is controlled by both current and time relays to insure automatic limitation of the starting current under all conditions of pumping. Illustrations of the switchboards, &c., are given in Figs. 8 and 9.

The pre-existing drainage pump for keeping the dock dry when a vessel is in it, has been replaced by a vertical spindle centrifugal pump which is driven by a 440-volt alternating-current motor, the combined set being very similar to, but of a smaller size than, the pumping units for No. 1 Dock and controlled in an identical manner. The priming of the main and drainage pumps is done by an air exhauster pump of the rotary type, which is direct coupled to a 15 brake horse-power 440-volt alternating-current. The blades of this rotary pump were specified to be of "Firth-Brearley" steel to obviate the liability of rusting. Special arrangements are made by barometric pipes to prevent these pumps from becoming flooded by water, and also to prevent water vapour from accumulating.

As there was a vessel in the dock during our visit of inspection, it was impossible for us to see the main pumping plant in full operation, yet we were given an opportunity of ourselves starting and stopping one of the units, and we were able to observe the ease with which both operations were performed and rapidity with which the motor ran up to full speed.

In concluding this article, we feel that some mention should be made of the clever way in which the new plant has been fitted into the old buildings. Saving that both pumping station roofs are higher than they would have been made had they been expressly designed for the plant which they now contain, because they originally housed vertical steam engines, there is no outward sign that they were not specially built for their present purpose. It should be stated, too, that the new plant was installed without in any way interfering with the services of the docks, which continued to operate without hindrance during the transition period.

## Wire Chain Making.

No. I.

In our description of the exhibits at the British Industries Fair a brief reference was made to the stand of Chains (Jewellers), Limited, on which there were at work several machines producing wire link chains, and we now proceed to give a more detailed description of the processes and machines employed in the industry. It should be pointed out, however, that much of the apparatus described below was not shown at Castle Bromwich, and that the following article is based on an exploration of the works in Birmingham under the guidance of Mr. Vincent, the company's engineer.

There are, of course, several distinct types of chain made from wire, such, for instance, as jack chain, knotted chain, curb, and trace chain. Each type is firstly concerned with the last two types. The machine used to form the wire into the chain links is a most ingenious and complicated affair; but before describing its mechanism it will be well to give some attention to the wire from which the chain is made.

Wire chains are made of all sorts of metals, from gold to steel, and while it is not general to solder the joints of steel chains, with the softer metals soldering is necessary to prevent the links opening under tension. It would obviously be a most tedious business to solder each link separately by ordinary means, so the necessary solder is provided in the body of the wire itself in the form of a core.

The billet of metal from which the wire is to be made is drilled throughout its length and the hole is filled with solder while the billet is at a red heat. The solder used varies with different metals, as it is necessary that there should be no tendency for the two to separate on account of different coefficients of expansion, while the melting point of the solder must naturally be below that of the wire it is to unite. The cross sectional area of the solder is approximately 15 per cent. of that of the billet, and this proportion is retained throughout the subsequent process of rolling and drawing down to wire.

In the making of the wire for rolled gold chain—that is to say, wire which is cased with a thin film of gold—a further preliminary operation is necessary. For this work a solid-drawn gold tube about 3ft. long by 2in. in diameter and having a wall thickness ranging from $^1/_{10}$in. to $^1/_{32}$in. is obtained, and a yellow metal rod is carefully turned to be just an easy fit inside it. The rod is silvered all over, and when it is slipped into the tube and the two heated to a dull red heat the silver "sweats" the gold and bar together. The rod is provided with a solder core, as already described, and the composite rod is drawn down to wire of almost any degree of fineness.

In this way a wire of reasonable mechanical strength can be made which has all the appearance externally of being of gold throughout, but the film of the rare metal is extremely thin, perhaps only 0.0001in. thick. In the trade the rolled gold is described as being of $^1/_{10}$, $^1/_{20}$, $^1/_{40}$, and $^1/_{60}$th quality; that is, if the wire or sheet is of $^1/_{10}$th quality and 0.01in. diameter, the gold will be 0.001in. thick; the $^1/_{40}$th would be 0.00025in. for the same diameter. The length of time it takes to wear this gold away varies, of course, with the thickness of the material. The $^1/_{10}$th quality is about the best and is warranted by the makers to wear for twenty years.

Reverting now to the actual making of the chain, it will be readily appreciated that the machine which cuts off and bends the wire into links, threading the links together at the same time, must be of a highly complicated form, and it would be impossible within the bounds of a single article fully to describe the whole mechanism. It is hoped, however, that the following explanation may give some idea of the process, and it must be left to the imagination of the reader to fill in the gaps, such as the driving connections between the working tools and the main shafting. It is sufficient for the present purpose to say that all the movements are effected by cams, keyed on to a single shaft and connected with the tools by levers, sometimes assisted by secondary cams or slides where it is necessary to change the plane of movement.

As will be seen from Fig. 1, a chain-making machine is quite a small affair, although it has so many moving parts. The example illustrated is one made by

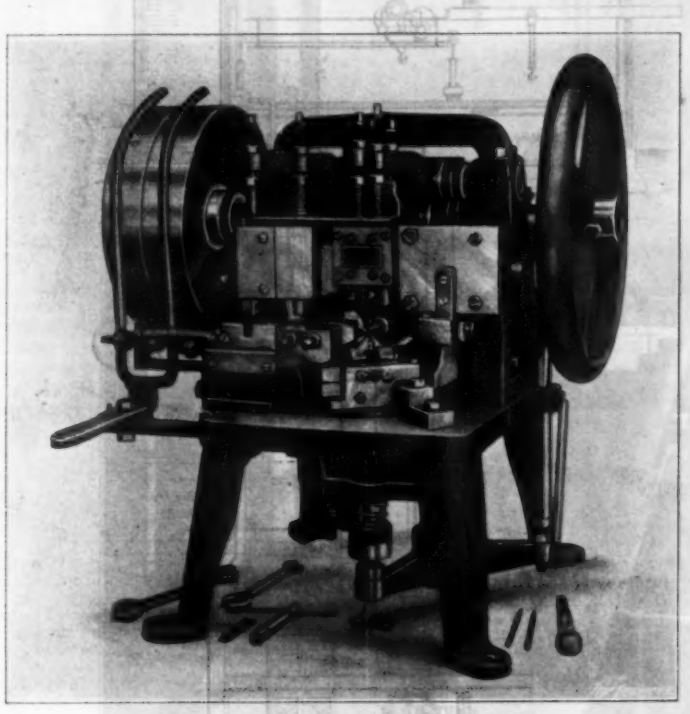


FIG. 1—TRACE CHAIN MAKING MACHINE

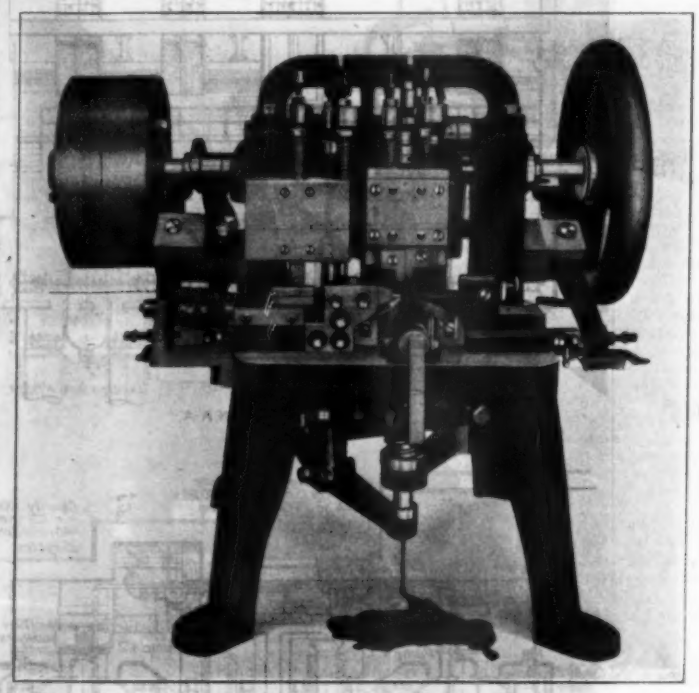


FIG. 2—CURB CHAIN MACHINE WITH TOP TWISTER

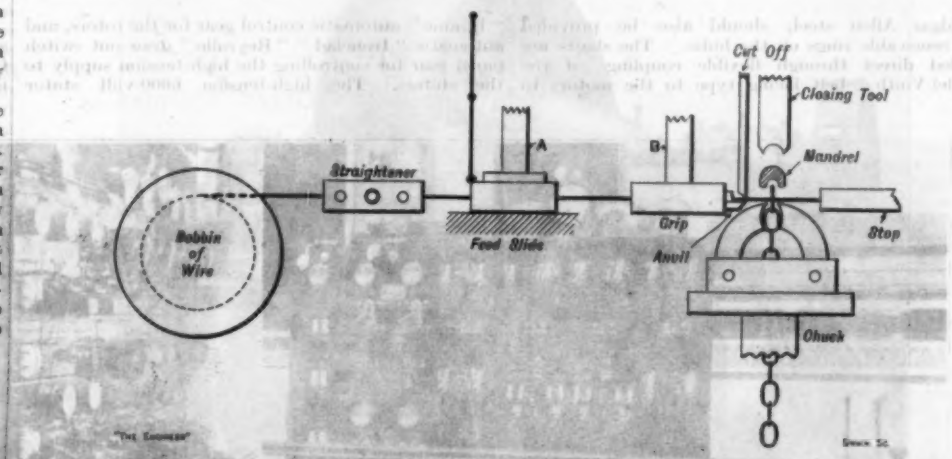



FIG. 3—DIAGRAM OF TRACE CHAIN MAKING MACHINE MECHANISM

Chains (Jewellers), Limited, and is capable of turning out about 100 yards per day of eight hours according to the number of links per inch of chain, as every revolution of the cam shaft completes one link.

In this engraving the main cam shaft can be seen running along the top of the machine. The bobbin of wire is carried by a bracket fixed on the left of the framing and the made chain hangs below the table.

The operation of the machine can best be followed with the aid of Fig. 2, which is merely a diagram indicating the various essential working parts and does not pretend to be to scale.

The stock of wire is drawn off the bobbin through a simple straightener by a feed slide. This feed is given a stroke equal to the length of wire necessary to make one link by the rocking lever indicated, and

during the forward stroke the wire is gripped by the pressure of the cam plunger A. On the return stroke the pressure is released. The feed block, by the way, slides under the end of the plunger A. The wire goes on to a second grip, on which the plunger B presses during the return stroke of the feed slide. Emerging from the grip, the wire is projected across a gap against a stop and is then cut off by a vertical tool, which just does not touch the anvil below, a very accurate stop being provided to limit its stroke.

Now, assuming that chain making has already been started, there will be a link in the gap of the

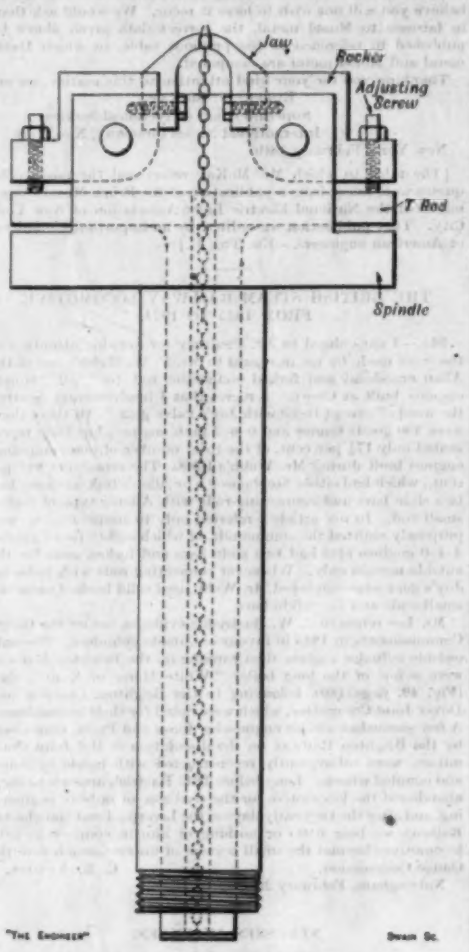



FIG. 4—CHUCK MECHANISM

machine, and the new piece of wire will be threaded through this link. Directly below the gap there is what may be described as a two-jaw chuck on a vertical spindle, through which the chain is delivered. When the wire is threaded through the last link the chuck jaws will be open, in the position shown, and the chain is then supported by the bridging wire. At this moment a horizontal mandrel, the end of which is indicated, comes forward over the wire between the jaws of the chuck and by moving downward bends the wire into the form of a U. It will be noticed that there is a little groove on the lower side of the mandrel to accommodate the top of the last made link. The jaws of the chuck close on the U just formed and the mandrel retires. A closing tool then descends from above and, by a steady pressure, succeeded by a sharp blow, bends the limbs of the U together to form a closed link. The chuck retains its grip on the chain and makes a quarter revolution, rising slightly at the same time, so as to present the link in the proper position for the next wire to be threaded through. Immediately the chain is supported by the wire again the chuck returns to the position indicated in the sketch and the process is repeated. The mechanism for opening and closing the chuck is indicated in Fig. 4, from which it will be seen that the two jaws are replaceable pieces fixed to rockers pivoted between the cheeks of the body. The shank or spindle of the body is bored and accommodates a hollow rod which spreads out at the top to form a T head. This head bears against two adjusting screws on the rockers, and when the rod is pushed up the jaws are closed on the chain link. The lever for pushing up the rod and the spring for its retraction can be plainly seen in the base of the machine in Fig. 1.

It will be seen that the made chain is continuously rotated by the chuck, and if it were allowed to accumulate on the floor with the twist in it it would become so entangled as to be useless. For this reason a turntable is arranged beneath the machine and is rotated at a quarter of the speed of the cam shaft, so that the turns are taken out of the chain as it is made. This turntable is not shown in Fig. 1, but it is a simple affair, arranged beneath the bench that carries the machine and is driven by a gut band from the cam shaft.

So far we have only described the making of trace chains—that is to say, chain with plain oval links—and it is in this way that chain down to as fine as forty links per inch, made of wire 0.007in. in diameter, is made. The working tools for making this fine chain are obviously very small and delicate, and it is necessary to use a magnifying glass in setting up the machine.

The machine for making curb chain, that with twisted links, is even more complicated; but before describing it, we must follow the trace chain through the subsequent operations.

The joints of the links at this stage are merely pressed together and, except with steel wire, the chain has no appreciable strength, so the joints must be soldered. For this purpose the chain is taken to another machine, in which, after passing over a feed drum, it is heated by Bunsen burners to such a temperature that the solder core in the wire is melted. The wire is then allowed to cool down and all the joints, it will be found, are firmly soldered. The remarkable thing is that the whole chain is not soldered up into a solid bar. The secret of success lies, of course, in careful regulation of the heating and cooling and in the accuracy of the joint made by the closing tool. The chain now only requires cleaning and polishing to be ready for the market. Some of the fine chain, such as that used by jewellers for guards, is, however, converted to the curb form by the simple expedient of twisting it longitudinally by means of a rotary spindle.

The mechanism of the curb chain machine is the same as that already described, in so far as the straightener and feed gear are concerned, but there are several additional parts at the gap and they are roughly indicated in Fig. 5. Fig. 2 gives a general view of one of these machines.

The wire grip and cut-off are much the same as those of the trace chain machine, and on the opposite side of the gap there is a stop, but it is provided with a mechanism to withdraw it when it has performed its function. The wire is fed across the gap over the top of two jaws and is cut off as before, while the mandrel then forms a U as for trace chains. Curb chain, which is twisted before soldering, is generally made of heavier gauge wire than is trace chain, and the closing of the joint is consequently more difficult. For this reason the first operation in forming the oval is for two fingers, indicated in the view, to advance horizontally from the front of the machine on either side of the limbs of the U and to bend the limbs together by approaching one another. The closing tool then comes down from above and completes the joint.

The link, in this condition, is a plain oval and it has

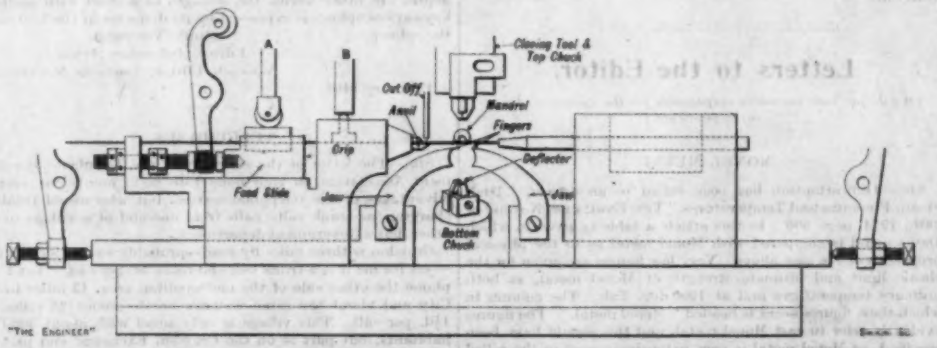



FIG. 5—CURB CHAIN MAKING MACHINE MECHANISM

to be twisted, on itself lengthways, through a quarter turn to make the curb form. This operation is performed by the two chucks or twisters indicated in Fig. 5. The top chuck comes down and grips the top of the link, while the bottom chuck takes hold at the bottom. In order to get the completed chain out of the way of the bottom chuck jaws, so that they may grip the link sideways, a little deflector advances from the front of the machine and pushes the chain aside to expose the bottom of the last made link, which is still held by the main forming jaws.

As soon as the chucks have got hold of the link the forming jaws open, the stop retiring as they swing back to make room for them. The chucks then make a quarter turn, relatively to one another, and the link is finished. In some machines the twist is made by the bottom chuck, and then a receiving turntable is needed for the chain; but in others the top chuck makes the twist and a turntable then becomes unnecessary, as the twisting brings the link into position to receive the next piece of wire. In either case it is, of course, necessary for the chuck last holding the link to rise slightly at the end of the operation so as to bring the link high enough for the wire to be threaded through.

The subsequent operations of soldering and so forth are the same as with trace chain, but curb chain is generally passed through a simple swaging machine, after it is soldered, to level out the links.

## Books of Reference.

*The "Practical Engineer" Electrical Pocket-book and Diary*, 1925, which is published by Humphrey Milford, Amen Corner, E.C. 4, price 3s. 6d., appears this year in its twenty-sixth edition. We are informed in the preface that Section IX. on Single Phase and Polyphase Alternators and Section XI. on Transformers and Converters, have been revised and largely rewritten by Mr. A. T. Dover, M.I.E.E., who is the Head of the Electrical Engineering Department of the Battersea Polytechnic; while Section XVII. on Primary Batteries and Section XVIII. on Storage Cells have been similarly dealt with by Mr. W. R. Cooper, M.I.E.E. We notice, too, that there have been additions in various places which have gone to make this year's volume even more useful than those which have preceded it.

*Mechanical World Year-book*, 1925, obtainable from the publishers, Emmott and Co., Limited, at either 65, King-street, Manchester, or 20, Bedford-street, London, W.C. 2, price 1s. 6d. net, is now in its thirty-eighth year of publication. The new edition contains several fresh features. There are, for example, a section dealing with surface condensers for steam turbines, and another concerned with foundations for machinery. Several other sections, notably those on gas engines, oil engines, Diesel engines, and suction gas producers have been rewritten, while the section on structural iron and steel work has been extended so as to include a number of useful tables. The section devoted to "Notes on Foundry Work" embodies a number of tables and much information concerning iron mixtures, tests, sands, cupolas, &c., which should be found useful both by pattern makers and foundrymen. Various other innovations and rearrangements have been made and several new illustrations have been added.

*Official Year-book of the Scientific and Learned Societies of Great Britain and Ireland.* Published by Charles Griffin and Co., Limited, Exeter-street, Strand, London, W.C. 2, price 15s., appears this year in its forty-first annual edition, and it is, what it purports to be, a record—and a most useful one—of the work done in science, literature and art by numerous societies and Government institutions during the session 1923–1924. It calls for no word of introduction or commendation from us, and we need only say that, in this year's volume, seven additional societies have been added to its already long contents.

*The Directory of Contractors and Public Works Annual*, published by Wightman and Co., Limited, 104, Regency-street, Westminster, S.W. 1, price 15s., appears in its 1925 edition for the first time since the war, and there will be many who will welcome the revival of what was, in pre-war years, an extremely useful book of reference. The present edition contains lists of contractors for:—(*a*) Railways, Docks, Harbours, Piers and Bridges; (*b*) Dredging and Reclamation; (*c*) Water Works; (*d*) Gas Works; (*e*) Tramways; Roads and Drainage; (*f*) Reinforced Concrete; and (*g*) Buildings; Cartage, Haulage and Lighterage. Then there are information concerning and lists of Railway Engineers, Locomotive Superintendents and Mechanical Engineers, Carriage and Wagon Superintendents, Railway Store Keepers, Consulting and Constructive Railway Engineers, Waterworks Engineers, Professional Sanitary Engineers, Architects, and particulars of the Corporation of the City of London, the London County Council, the Port of London Authority, the Thames Conservancy, and the Metropolitan Water Board. Then follow lists of Dock and Harbour Engineers, County Surveyors, London District Surveyors, Town Clerks, City and Borough Surveyors, Urban and Rural District Council Surveyors, and Public Works under construction. Finally there is a Contractors' Plant and Material Buyers' Guide.

*Sell's Directory of Registered Telegraphic Addresses*, 1925, which is published by Business Dictionaries, Limited, 8 and 9, Johnson's-court, Fleet-street, London, E.C. 4, price 45s., appears this year in its fortieth annual edition. It is an invaluable book which is practically indispensable in every business office, and, for ourselves, we can truthfully state that we do not know what we should do without it. Quite apart from its utility as containing complete lists of telegraphic and postal addresses and of telephone numbers, information can frequently be obtained from it which is not forthcoming from other sources, or is, at any rate, only with difficulty accessible in other directions.

*Hütte des Bauingenieurs.* Volume III. Wilhelm Ernst and Sohn, Berlin, W. 66, Wilhelmstrasse 90. Price 18·48 Swiss Francs.—The third volume of this series of engineers' pocket-books appears this year in its twenty-first edition. Practically all branches of civil engineering are dealt with, and chapters are included on surveying and surveyors' instruments, reinforced concrete construction, factory design and builders' and contractors' machinery. The section on water power installations has been enlarged, and the construction of dams is dealt with at some length. A chapter on town-planning has been rewritten and extended to embody the latest developments in house build-

ing and sanitation. In dealing with railway work special attention has been devoted to that section relating to private sidings, while considerable additions have been made to the section on bridges and bridge building.

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*The "Mechanical World" Electrical Pocket-book*, 1925, published by Emmott and Co., Limited, 65, King-street, Manchester, and 20, Bedford-street, London, W.C. 2, price 1s. 6d., contains several new features, including sections on:—(*a*) Primary Cells, in which brief descriptions of the composition and characteristics of a number of the most used cells are given; (*b*) Testing Generators, Motors and Transformers; (*c*) Various Electrical Supply Systems; (*d*) X-rays, and (*e*) Electric Battery Vehicles. There are useful tables on:—(1) Mechanical Electrical Unit Equivalents, in which the equivalents given, though not taken far enough in deimal points to be absolutely accurate, are quite sufficiently near for all ordinary practical purposes; and (2) the horse-power necessary to drive different kinds of machinery. We notice that the Editor has resisted all temptation to refer to wireless telephony, and the only reference to wireless telegraphy which we have been able to find has do with earthing plates.

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*The "Electrician" Electrical Trades Directory and Handbook*, 1925—which is so well known under the name of "The Blue Book"—appears this year in its forty-third edition. It is published by Benn Brothers, Limited, 8, Bouverie-street, London, E.C. 4, and its price is 25s. net. It is quite unnecessary for us to enumerate the contents of this exceedingly useful work of reference, for it is so thoroughly well known by all who have anything to do with electrical matters. All that it will be necessary for us to do is to say that it has apparently been brought fully up to date, and that the portion of it which treats of the Law Relating to Electricity Supply, which constitutes the first portion of the Legal Digest in the Handbook Section, has been entirely re-written by a well-known barrister.

## THE COUNTING OF ATOMS.

In the first of his course of four lectures at the Royal Institution on "The Counting of Atoms," delivered on February 28th, Sir Ernest Rutherford said that during the past twenty-five years a variety of methods had been developed to estimate the mass of the individual atom of matter and the number of atoms in any definite weight of material. While all these methods gave concordant results, the precision of measurement varied widely in the different cases. Amongst others, we had been able to deduce the mass of the atom from a study of the Brownian Movement, i.e., the continuous agitation of small particles in liquids and gases, from a study of the blue of the sky, and from the determination of the unit of electric charge. Under certain conditions, it had been possible, as in the case of the "$\alpha$" particle from radium, to count the individual atoms and the number of atoms present in a definite volume of helium gas. Methods had also been developed to observe the tracks of single electrons and "$\alpha$" particles in swift motion, in their passage through a gas.

While the underlying idea of the atomic constitution of matter was put forward by the Greek philosophers 2500 years ago, and was generally current at the beginning of the scientific age, the atomic theory, as we knew it to-day, dated from its application by Dalton in 1808 to explain the combination of atoms in multiple proportions. This theory, coupled with Avogadro's hypothesis that equal volumes of gases at the same temperature and pressure contained an equal number of molecules, had made it possible to fix with considerable precision the relative atomic weights of all the known elements.

While the great superstructure of modern chemistry had been reared on the philosophic foundation of the atomic theory, it was unnecessary at first to make any definite assumption as to the size and mass of the individual atoms, but with the growth of scientific knowledge curious minds used every available opportunity to form an idea of the magnitude of atoms. A maximum estimate of the size of atoms could be made from a study of the thickness of the black spot in soap films and the thickness of an oil film spreading on water. Reference was made to the remarkable calculations in 1805 by Dr. Thomas Young, founder of the undulatory theory of light, who made the first estimate of the size of atoms, or rather of the range of their attractive forces from a consideration of the surface tension of water. This aspect of the question greatly attracted Lord Kelvin, who deduced from the energy required to stretch a water film that the molecule of water could not be more than one hundred millionth of a centimetre in diameter.

The development of the kinetic theory of gases on a mathematical basis by Clausius and Maxwell was a great step in advance, and first gave us a clear, if not a precise, idea of the size of atoms and the number of molecules in a cubic centimetre of any gas. Before, however, these rough estimates could be generally accepted, it was necessary to verify this theory. This had been accomplished by a close study of the Brownian Movement in liquids and gases, to be dealt with in the next lecture.

## THE INTERNAL COMBUSTION TURBINE.

A paper which Dr. T. B. Morley contributed to the proceedings of the Manchester Association of Engineers on Friday, the 27th ult., on "The Internal Combustion Turbine," furnished a very comprehensive review of this interesting subject. As the author remarked, the fact that this machine, so attractive in idea and so long studied, had not yet become a regular commercial success, indicates that there must be some serious difficulties retarding its development. Dr. Morley proceeded to explain these difficulties, and discussed in outline the cycles of operations and the means necessary to put them into practice. He described the theories of the constant pressure cycle, the regenerative principle, the mixed fluid cycles in which steam is used as a diluent, with certain proposed designs, explosion cycles, and the constant volume cycle. A good deal of space was devoted to the Holzwarth internal combustion turbine, and the author took as an example the machine built in 1908, which was designed to generate 1000 horse-power, but failed to yield more than 450 horse-power. Dr. Morley said that this output was open to considerable doubt, the fuel said to have been consumed per brake horse-power-hour and many other claims being demonstrably impossible; in fact, the actual efficiency of the machine was probably only about 13 per cent. In discussing the efficiency, the author complained of the untrustworthiness of the figures given by Schüle and Holzwarth, and the unsatisfactory form in which the reports had been published.

The author, in dealing with the prospects of the internal combustion turbine, considering first the question of fuel economy and cost, said that this class of machine was not likely ever to equal the internal combustion piston engine, but in comparison with the steam turbine, the case was not quite so hopeless. The decisive factor on which the success of the internal combustion turbine would depend was whether it could be constructed as a reliable mechanism, and that, again, was a question of its ability to stand high temperatures. The two types which Dr. Morley considered to have possibilities of success, provided the mechanical difficulties could be surmounted, are the constant pressure sub-atmospheric mixed-fluid turbine, with a steam turbine supplied from a regenerator, and the Holzwarth type. The paper was illustrated by a number of diagrams and half-tone pictures, several of which have already appeared in these pages—see The Engineer, December 18th, 1911; January 5th, 1912; February 11th, 1921, and June 8th, 1923.

## SIXTY YEARS AGO.

Our issue of March 3rd, 1865, contained a review of the first six monthly parts of Zerah Colburn's "great work now in course of publication," entitled "Locomotive Engineering and the Mechanism of Railways." The author had at that date ceased, we believe, to take an active part in the editorial duties connected with the production of this journal, but that fact did not prevent our expressing our sense of the great value and importance of his book. The contents of the work, with its piercing criticism of the reputations commonly assigned to Stephenson and other railway pioneers, must still be familiar to many of our readers. Our notice of the book interests us to-day less because of its account of the contents than because of the light it sheds on the attitude adopted by engineers sixty years ago towards mechanical history. If we can accept the statements of our reviewer the engineers of the time did not "affect engineering history." The mechanical engineers, the descendants of the old millwrights, prided themselves as being "sound practical men," and held in something of contempt and regarded as unsound and unpractical anyone who made much of engineering literature. Yet when the chance came they were quick to correct any wrong attribution of merit in connection with early designs or inventions. They believed greatly in the proverb *palmam qui meruit ferat*, although nine-tenths of their number would probably fail to understand it unless it were interpreted to them as "give the devil his due." This contempt for, and impatience of, mechanical history was, we recorded, once shared by Colburn himself. A few years previously, in a work on permanent way, he had overborne the idea of his collaborator, Mr. Holley, that the book should contain a chapter on the history of this subject. Yet Colburn—we wrote—the sound practical man who prided himself upon having begun the study of locomotive engineering at the age of fourteen, and upon having been the mechanical manager of a considerable locomotive factory before he was nineteen, had not only survived the objection of his brethren to written mechanical history, but had by virtue of his newly published work become without question *the* historian of the locomotive engine. The value of Colburn's "Locomotive Engineering" as a source of historical evidence is open to some doubt to-day, but he certainly did a very great deal to rescue from forgetfulness facts which, with the then prevailing indifference to mechanical history, might easily have slipped for ever into oblivion.

# Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### MONEL METAL.

Sir,—Our attention has been called to an article, "High Steam Pressures and Temperatures," The Engineer, November 28th, 1924, page 606. In this article a table is given in which Davis metal is compared with Monel metal as to the physical properties of the cast alloys. Very low figures are given for the elastic limit and ultimate strength of Monel metal, at both ordinary temperatures and at 1000 deg. Fah. The column in which these figures occur is headed "Monel metal." The figures evidently refer to cast Monel metal, and this should have been specified, as Monel metal is very extensively used in the rolled form. The physical properties of rolled Monel metal are much higher than for castings. It is also stated in the text that the use of Monel metal, "in cast form, was limited on account of a number of difficulties involved, and discouraging to the utmost on account of the prevalence of imperfections and porosity which were not discovered until the castings, machined and assembled into valves, were tested under hydrostatic pressure, when the porosity would be revealed."

The correct physical properties of cast Monel metal are as follows:—

| | |
|---|---|
| Elastic limit, pounds per square inch .. | 30,000 to 40,000 |
| Elastic limit at 1000 deg. Fah., pounds per square inch .. .. .. .. .. | 20,000 to 30,000 |
| Ultimate strength, pounds per square inch .. .. .. .. .. .. .. | 65,000 to 80,000 |
| Ultimate strength at 1000 deg. Fah., pounds per square inch .. .. .. | 50,000 to 60,000 |

The alloy may be cast into the required shapes almost as easily as iron and entirely sound castings may be readily obtained. Monel metal is a non-ferrous alloy of high nickel content, and therefore its metallurgy should be expected to be somewhat different from that of iron or brass. In making castings it is only necessary to make a few minor changes in the casting practice to ensure freedom from porosity. Instructions for the casting of Monel metal are distributed by the manufacturer, and may be obtained, free of charge, from the main offices of the company or from any one of the authorised agencies.

It is rather surprising to us that you have permitted such erroneous data to be published in this manner, particularly when the data is supplied by a company manufacturing valves which are sold in competition with such a widely used alloy as Monel metal. We are drawing your attention to this, as we believe you will not wish to have it recur. We would ask that, in fairness to Monel metal, the correct data given above be published in reference to the previous table, in which Davis metal and Monel metal are compared.

Thanking you for your kind attention to this matter, we are

Robert J. McKay,
Superintendent of Technical Service,
International Nickel Company, New York.

New York, February 18th.

[The table to which Mr. McKay refers and the passage he quotes were taken from a publication of the Prime Movers Committee of the National Electric Light Association of New York City. That publication was edited by an important committee of American engineers.—Ed. The E.]

### THE BRITISH STEAM RAILWAY LOCOMOTIVE FROM 1825 TO 1924.

Sir,—I am obliged to Mr. Poultney for drawing attention to the error made by me in regard to Mr. F. W. Webb's use of the Allan crosshead and forked connecting-rod for "all" simple engines built at Crewe. I regret that I inadvertently omitted the words "except those with Joy's valve gear." Of these there were 390 goods tender and 0–6–2 tank engines, but they represented only 17½ per cent. of the total number of non-compound engines built during Mr. Webb's time. The remaining 82½ per cent., which had either Stephenson's or Allan's link motions, had two slide bars and connecting-rods with Allan's type of forked small end. In my article I referred only to simple engines and purposely omitted the compounds, of which eighty four-cylinder 4–4–0 engines also had two slide bars and forked ends for the outside motion only. Whenever connecting-rods with holes for Joy's gear were employed Mr. Webb used solid bushed unforked small ends and four slide bars.

Mr. Lee refers to J. W. Rastrick's evidence before the Gauge Commissioners in 1845 in favour of outside cylinders. The only outside cylinder engines then running on the Brighton Railway were a few of the long boiler "White Horse of Kent" class (Fig. 49, page 180), belonging to the Brighton, Croydon and Dover Joint Committee, which were noted for their unsteadiness. A few somewhat similar engines by Jones and Potts, taken over by the Brighton Railway on the dissolution of the Joint Committee, were subsequently reconstructed with inside cylinders and coupled wheels. Long before 1845 Rastrick appears to have abandoned the locomotive for the civil side of railway engineering, and after the very early days of the Liverpool and Manchester Railway we hear little or nothing of him in connection with locomotives beyond the small portion of his evidence before the Gauge Commission.

E. L. Ahrons.

Nottingham, February 28th.

### STRESSES IN AXLES.

Sir,—I have been interested in your editorial on page 136 of the January 30th issue and also in the article by Dr. Hatfield in the Metallurgical Supplement.

In May, 1915, I contributed a paper to the American Society of Mechanical Engineers dealing with the study of an axle shaft, and in this I laid down certain ideas which I was glad to see corroborated by Dr. Hatfield's article and your comments.

I came to the conclusion in this that the total stress in a case where there were alternating stresses was the sum of the two stresses on each side of the neutral plane. Also that this should be the deciding factor in calculating the factor of safety. This immediately throws a light on the problem of failures due to varying and alternating stresses.

Incidentally I also laid down certain ideas in connection with the use of keyways or splines, pointing out that these always subtract from the strength of a shaft by an amount equal to their depth. In other words, the strength of a shaft with multiple keyways or splines is expressed by its diameter at the bottom of the splines.

John Younger,
Editor, *Automotive Abstracts*.
Associate Editor, *American Machinist*.

February 14th.

### TELEPHONES.

Sir,—The letter of the secretary of the Telephone Development Association, in your issue 13th inst., points out certain advantages of the telephone service, but who would think of charging, as trunk calls, calls from one end of a village to the other, but a Government department.

Croydon is three miles by road—probably two as a crow flies—yet for me it is a trunk call and costs 4d. per call. Yet I can phone the other side of the metropolitan area, 13 miles to the City and about the same distance north—about 25 miles for 1½d. per call. This village is only small with about 3000 inhabitants, but part is on the Croydon Exchange and part on the Ravensbourne (Bromley, Kent) Exchange, and any one phoning across from one district to another, say, half mile, is charged as trunk call. What a farce and a nuisance. What has the secretary of the Association to say to this?

A. F. Schove.

West Wickham, Kent,
February 28th.

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Questioned on February 19th as to the abolition of the guard's look-out window on passenger trains, the Minister of Transport said that such windows had not been provided on new passenger stock for a number of years, because the additional width of the carriages made it impossible, having regard to necessary clearance, to provide them. The inspecting officers had not regarded the windows as being necessarily required for the safety of passenger traffic.

## Improved Electrical Instruments.

Two useful and ingenious electrical instruments have been added to the large collection now available by the Record Electrical Company, of Broadheath, Manchester, one being the change coil multi range test set for alternating and direct currents—shown in Fig. 1—and the other the moving iron "Cirscale" ammeter—shown in Fig. 3. The former is a combined ammeter and voltmeter, with a range of 1 to 600 ampères. By means of shunts and resistances, it is, of course, possible to make a direct-current instrument give readings ranging from very small currents up to currents of several hundred ampères, but an equivalent alternating-current instrument, the Record Electrical Company points out, has not been produced. Alternating-current instruments, involving the use of shunts or the subdivision of the working coils into series or parallel groups, do not give a large variation in the range, but the instrument under consideration overcomes the difficulties that have hitherto been met with, and it is also claimed to give a high degree of accuracy.

It consists of a moving iron movement and an energising

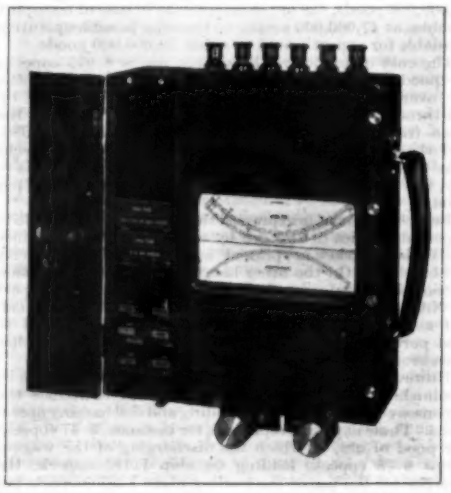


FIG. 1—CHANGE COIL MULTI-RANGE TEST SET

coil, which can be replaced by other coils with different current capacities, so that the range of the instrument can be altered with very little trouble. These change coils, which, when brought into use, are connected in the circuit by means of terminals outside the case, can make the instrument give a very wide range, for any desired number of coils may be used, and their current-carrying capacities may vary considerably. A coil which will produce a full-scale pointer deflection of 1 ampère, for instance, can be changed, in a very short space of time, for another coil which will make the instrument give a reading of 600 ampères.

The instrument is made to comply with the British Standard Specification No. 89 for first-grade accuracy, and it can be used on alternating and direct-current circuits provided the frequency does not exceed 500 in the case of current measurings, and 100 cycles when measuring voltage. The ability of the instrument to give alternating current and direct current readings within these limits is an important advantage from the point of view of the commercial user and the electrical inspector, who can

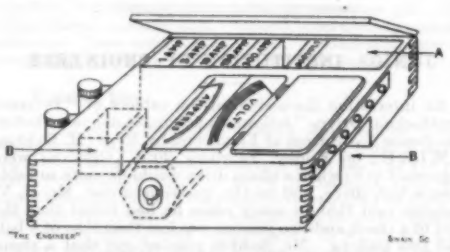



FIG. 2—ARRANGEMENT OF CHANGE COIL TEST SET

carry out tests on different kinds of circuits with a single instrument, and a test for accuracy can be made with direct current.

The general construction of the instrument can readily be understood from the illustration—Fig. 2—where the receptacle for receiving the various coils is shown at A, and the cavities for the coils that are in use at B, the cavity for the current coil being on the left, and that for the volt coil on the right. When the selected coil has been placed in one of these cavities, the bore of the coil fits over a protruding tube which contains the moving iron and spindle, to which the indicating pointer is attached, and the coils are held in position by thumbscrews which at the same time establish electrical connection with the terminals.

As the current coils are in series with the main circuit, the whole of the current to be measured passes through them, thus entirely eliminating temperature, frequency and other errors which are associated with alternating-current instruments used with shunts. Although each of the changeable coils is wound with the same number of ampère turns, it has been found in practice that the effective magnetism varies. A common scale with a multiplying factor cannot be used, and each coil has to be calibrated separately, and as the standard set contains six current coils, six scales are necessary. If all these scales were marked adjacent to one another on the same dial the dial would be very overcrowded, and confusion would arise when taking the readings. To overcome this difficulty, therefore, the instrument is provided with a hexagon drum. A scale is marked on each of the sides, and by revolving the drum any one of these six scales can be brought into use.

In the standard set five voltage ranges are provided for, but there are only two changeable coils, the intermediate ranges being obtained by tappings taken from non-inductive resistances connected to separate terminals. Each of the two volt scales which are used with the two changeable coils is accurately calibrated, and a multiplying constant is used for the individual ranges. There is a separate terminal for each tapping instead of the more common range-changing switch, with the result that the chances of error are reduced.

For voltages above 750 use must be made of potential transformers, with 110-volt secondaries, which are connected to the 150-volt range coil, whilst for currents above 600 ampères current transformers with 5-ampère secondaries are connected to the 5-ampère range coil. For reasons of lightness and portability, the current coils

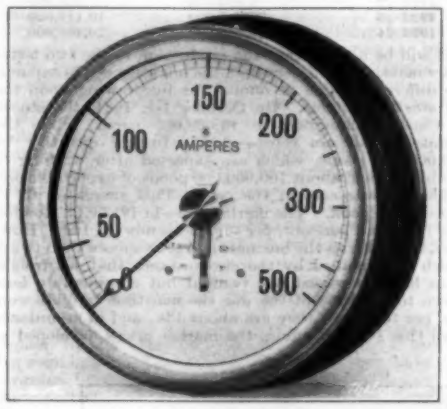



FIG. 3—"CIRSCALE" ALTERNATING CURRENT AMMETER

and terminals are designed to work at high current densities, and they are not intended to be left in the circuit for long periods when they are carrying the full load. If a long test has to be made, a coil should be selected that is designed for twice the maximum current that has to be measured, when the current can be allowed to pass through the instrument indefinitely.

The "Cirscale" ammeter is shown in Fig. 3. The construction of a moving iron instrument with a pointer deflection of more than 170 deg. has hitherto been considered an impossible task, but by the use of a special form of movement—as shown in Fig. 4—a pointer deflection of 280 deg. has been secured. It will be perceived from Fig. 4 that the movement is really composed of two repulsion movements A and B, which are separately pivoted, and they are assembled one behind the other, as shown. The fixed iron C of the rear movement is of the usual scroll form, whilst the moving iron A consists of a single narrow rectangular plate. The spindle carrying this has an extension, which carries one of the irons of the front movement,

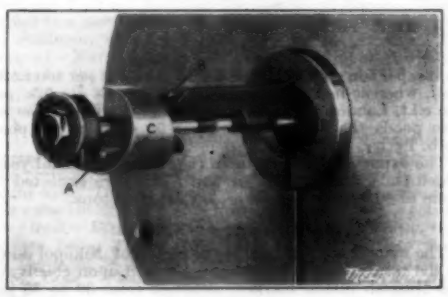



FIG. 4—MOVEMENT OF "CIRSCALE" AMMETER

which consists of two thin irons parallel to one another, but in this instance the iron corresponding to the fixed iron of an ordinary movement is carried by the rear spindle, and its companion iron is independently pivoted on the spindle, which carries a pointer that is controlled by a spring and is damped with an air dashpot, just as in the case of an ordinary simple movement. The complete movement is surrounded by a single coil which is wound on a former and impregnated, no supporting spool being necessary, whilst in order to increase the magnetic field and to screen the instrument from external fields, a thin sheet of soft iron is made to surround the coil. When current flows in the coil the irons of each combination are similarly magnetised, with the result that they repell one another, and as the moving iron of the back member separates from the broader surface of the fixed iron, it moves forward the repelling iron of the front member, which is repelling its moving iron. As a result of this arrangement, the two systems are magnetically in tandem and the angular deflection of the pointer which is carried by the front spindle is increased to about 280 degrees. The construction does not involve increasing the depth of the case, and whilst a second set of jewel bearings is essential, the friction error is not appreciably increased because the operating parts are also increased. An air dashpot provides the necessary damping. The moving iron "Cirscale" instrument is intended mainly for alternating currents, whilst the maker's permanent magnet "cirscale" meters are essentially direct current instruments. As will be seen from Fig. 3, the scale is an exceedingly open one, at the half scale reading, and that it closes up rapidly towards the maximum reading. In the case of suppressed zero voltmeters, constructed on this principle, the greatest deflection for a given change of voltage is in the middle of the scale, the best position of the pointer for a declared or station voltage being vertical.

## Design for a Cellular Gravity Dam.

By REGINALD RYVES, M. Cons. E., A. M. Inst. C.E.

SOME unusual features are presented in a design for a gravity dam described, with a drawing, in a recent issue of *Annali dei Lavore Pubblici* by Ing. Edoardo de Gastani. Having studied the case of the arch dam as a type suitable for gorges in sound rock and that of the curved gravity dam, which is suitable for a wider range of site conditions, Sr. de Gastani has sought to design a type of gravity dam, the adoption of which will reduce the cost due to the great thickness of costly masonry or concrete, especially for very high dams, and reduce also the upward pressures occurring when water under the reservoir head penetrates between the dam and the rock.

The design is based on criteria or conditions which may be briefly expressed as follows:—(1) The exclusion of any kind of reinforcement and the employment of cement concrete, prepared entirely by machinery in order to ensure uniformity and impermeability. (2) The adoption of the triangular cross section and the areas of cross sections of a gravity dam; transverse internal walls to be built simultaneously, if not throughout the length of the dam, at least in defined portions of the length. (3) The provision of an impermeable upstream shell increasing in thickness from the top to the base, the proportion of cement in this shell being higher than that in the transverse walls. (4) The provision of a downstream shell having similar dimensions, but not having more than the normal proportion of cement. (5) The transverse walls to be each on a foundation of its own, upon the rock, and decreasing in thickness from the base upwards, these walls being joined by horizontal arches running from the upstream shell to the downstream shell with increasing spans from base to crest of the dam, in conformity with the diminishing thicknesses of the transverse walls. In these arches the proportion of cement may be less than that in the transverse walls, or the normal proportion for the dam. (6) The structure being thus a series of transverse horizontal chambers of widths decreasing from the crest to the base, the latter must not be left empty, but must be filled with materials which are as cheap and as heavy as possible, the filling being done as the walls are raised. The whole will form a compact mass of high specific gravity and the tunnels will provide drainage from behind the upstream shell wall.

The section shown in the *Annali* is that for a water depth of 90 m. or 295ft. to river bed, in this case an apron of concrete about 2 m. thick resting upon the rock. The freeboard of 3 m. gives a total height of 93 m., or 305ft., and the base at river bed is 67 m. wide. The foundations of the shell walls are trenched into the rock, as are those of the transverse walls, without footings. The transverse foundations are zigzagged in their length, but are not shown as designed to furnish surfaces at right angles to the local pressures. The foundation of the downstream shell wall has, however, its bottom surface at right angles to the downstream face. Both faces are straight, the upstream batter being 1 in 10 and the downstream batter about 1 in 1¼. The prolongation of the downstream face meets the upstream face at water level, the dam being thus of the elementary traingular section with a small crest addition, which has an upstream face of 3 m., a downstream face of about 12 m., both vertical, and a crest width of about 6 m.

The drawing is not dimensioned, but is drawn to scale, and scalings give the following approximate dimensions for the proportions which the designer proposes to adopt. The upstream shell wall is about 1¾ m. thick near the top, increasing regularly to about 4 m. near the base and 6 m. at its foundation on the rock. The downstream shell wall is rather less than 1¼ m. thick near the top, increasing to about 3½ m. near the bottom and widening to a foundation nearly 7 m. in width. In the crest portion the shell is 2½ m. thick at 12 m. below the crest (a step in thickness from that just below) and 1¼ m. just below the crest. Downstream it is about 1¾ m. thick throughout the 12 m. of the vertical portion. The transverse walls are about 1 m. thick at the top, increasing regularly to about 3 m. at the base, and 4 m. at the foundations. These walls are spaced at about 6 m. centres, leaving 2 m. wide strips of rock between. There are sixteen rows of arches, with tunnels 10 m. in height, and of widths decreasing from about 5 m. in the top row to 3 m. in the bottom row. The arches are about ¾ m. thick at their crowns, and the floor above each arch is level.

### SOME COMMENTS.

(*a*) If we start with a profile showing a not very greatly curved downstream face, and regard it as suitable for a dam of the same specific gravity throughout, the adoption of a construction resulting in an increasing specific gravity from crest to base logically tends to flatten this curvature towards, or to, a straight line.

(*b*) This cellular form, the internal lengthwise elements of which are of a poorer concrete than that in the walls and consist of somewhat thin arches, is not well designed to effect the sharing of stresses which may result from unequal resistances in different parts of the foundation. Nor are the shells thick enough effectively to unite the resistance of one part of the dam to that of adjoining portions. On river cross sections presenting irregularities of considerable extent and fairly sharp, similar considerations arise.

(*c*) On deep and short river cross sections, and especially when one side is much steeper than the other, some misgivings may arise as regards normal deflections under water load, the dimensions of the shells, and the nature and quality of the horizontal resistances lengthwise of the dam.

(*d*) All things considered, it would be better to replace the arches by flat slab elements, of greater thickness and normal cement content.

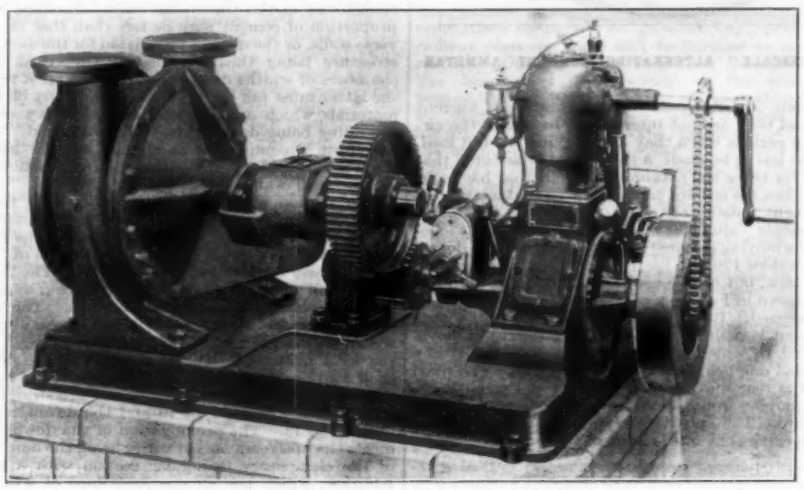
(e) By trenching in the transverse walls separately the resistance to shear is perhaps increased; but immediately above the foundation the shear-resisting area is much less than in most types of gravity dams. Conditions of local rock weakness, which could not harm a solid dam, might cause progressive weakening in this type.

(f) As a matter of principle, the placing of rubble or of earthy materials in separate chambers seems to be somehow wrong, because we lose the resistance due to interlocking. It does not seem to be an economical use of the material itself or of the money which it costs to obtain and to place it. Note, for instance, the position of the rubble in the R. Stanislaus dam, Sierra Nevada, and the Rio Grande dam, Colorado; also the tunnel chambers as a backing in a dam near Domodossola.

Sr. Gaetani refers to issues of the *Giornale del Genio Civile*, 1923, containing articles by Professor Luigi Luiggi and Sr. Valentino Cardi. Other matter of interest as regards points raised by Sr. de Gaetani's design will be found in Professor Luiggi's paper presented to the Engineering Conference at Siena, 1913, *Revista L'Industria*, Vol. XXVIII., Nos. 7 and 11 to 14, 1914. Also Bancroft's proposed type, 1910, with vertical chambers containing rubble. Sr. de Gaetani is probably the first engineer to put forward a design in which the use of a filling material such as rubble is associated with a cross section of small area in proportion to the height.

## A Small Centrifugal Pumping Set.

WE show in the accompanying illustration an interesting application of the small marine type petrol motor. The set in question was recently built by J. W. Brooke and Co., Limited, of Lowestoft, for the Cantley Beet Sugar Factory at Cantley, Norfolk. It comprises one of the firm's standard single-cylinder marine motors, which has been adapted for commercial use. The engine is designed to give an output of 4 brake horse-power when running at a speed of 900 revolutions per minute, and it is coupled through reduction gearing to a centrifugal pump of the



CENTRIFUGAL PUMP DRIVEN BY 4 B.H.P. PETROL MOTOR

Roto-Plunge type, designed to work at a normal speed of 380 revolutions per minute.

The purpose for which the set has been installed in the Cantley factory is to drain the water from the beet pulp after the syrup has been extracted from it. It is a low head type of centrifugal pump with 3in. delivery and suction booster and works under a total head of about 12ft. with a rated capacity of about 7000 gallons per hour. With the large amount of beet to be dealt with it is necessary to run the set continuously. At the time of writing the engine we illustrate had been running, so the makers inform us, for one month without intermission. This result speaks well for the reliability of the engine, which is neatly grouped together with the gearing and pump on a substantial cast iron bed-plate.

## The Manganese Ore Industry of Russia.

THE problems of the export of iron ore and manganese ore from Soviet Russia are far from being identical, as the country is relatively richer in the latter than in the former kind. As a consequence the export of manganese ore in the pre-war period, as at the present time, played and still plays a considerably greater part than that of the export of iron ore.

These circumstances are pointed out by Mr. V. Sverdloff in the Moscow *Ekon. Sjisn*, of January 6th, he stating that down to the outbreak of the war Russia exported over 1,000,000 tons of manganese ore, or about one half of the world's consumption, while the inland demand in Russia was only about 16 per cent. of the quantity exported. In the case of iron ore the Russian consumption in 1913 amounted to some 10,000,000 tons, and the exports were slightly less than 1,000,000 tons, so that the former was ten times the tonnage of the latter. Moreover, the export of manganese ore yielded considerably better results per pood than the export of a pood of iron ore. On economic conditions the export of manganese ore can proceed from two locations of the deposits, that is to say, from Chiatur (Tchiaturi) and Nikopol.

The district of Chiatur, which the author first discusses, yielded 59,000,000 poods of manganese ore in 1913, and the exports amounted to 65,000,000 poods. In consequence of the absence of Russia from the world market during the period of the imperialistic war and the term of the revolution, a state of famine in manganese ore began in 1921–22 in the West of Europe and America, the result being a considerable advance in prices. Although after Russia, India and Brazil are the chief producers of manganese ore, and their output was increased, it has been impossible for these two countries to supply the market to such an extent as to bring sale prices to an approach to those which existed in 1913, so that the prices have remained down to the present time above the level of the pre-war period. The situation of prices in regard to manganese ore is analogous to that of platinum, of which Russia produced some 90 per cent. of the world's total outturn in 1913.

The principal customers for Russian manganese ore in 1913 were Germany, which absorbed 25 per cent. of the exports; and then England, Belgium, France, the United States, and other countries. After the revolution in Russia the production and exports of manganese from the district of Chiatur developed in the following manner:—

| Year. | Production in poods. | Exports in poods. |
|---|---|---|
| 1921–22 .. .. .. | 1,895,000 .. .. | 1,558,000 |
| 1922–23 .. .. .. | 9,200,000 .. .. | 10,114,000 |
| 1923–24 .. .. .. | 19,543,000 .. .. | 29,405,000 |

It will be noticed that the production in the two latter years mentioned was less than the quantity of the exports, the difference being accounted for by drawing upon the old stocks available. On October 1st, 1924, the stocks in Chiatur amounted to 13,609,000 poods, while the dumped small ore represented a further quantity of 200,000,000 poods, which are expected after washing to be able to yield about 100,000,000 poods of exportable ore.

The pre-war cost of the ore at Poti amounted to 17 copecks per pood. The market price in 1913 c.i.f. London was 11d. per 1 per cent. per ton and is now 1s. 10d. However, the profit on the business had grown more than twice, which is explained by the circumstance that sea freight rates have increased not twofold but considerably less. Down to the time of the war the maritime freights were 10s. per ton; now they are about 12s., and in accordance with this state of affairs the market prices developed as to 46s. per ton c.i.f. London in 1913, and 36s. per ton f.o.b. Poti, whereas now the corresponding figures are 92s. per ton c.i.f. London and 80s. per ton f.o.b. Poti. Converted into poods the latter figure gives 58 copecks per pood f.o.b. Poti.

The exports from Chiatur in the current financial year, which ends with September 30th, 1925, are expected to come to 30,000,000 poods, or, say, 482,000 tons.

### THE DISTRICT OF NIKOPOL.

The manganese deposits in the region of Nikopol down to the time of the revolution were drawn upon chiefly for the Russian inland market, although from 30 to 35 per cent. of the outturn was sent to other countries. For instance, in the year 1913 5,600,000 poods were exported out of the total production of 15,700,000 poods in this area in that year.

At the present time the manganese ore mines in Nikopol, which are in the hands of the Southern Mining Trust, have so far developed the production that after having satisfied the requirements of the home demand, there still remains a considerable surplus for exportation. The movements in the past three years in this district are show by the accompanying figures:—

| Year. | Production in poods. | Exports in poods. |
|---|---|---|
| 1921–22 .. .. .. | 1,319,000 .. .. | 1,914,000 |
| 1922–23 .. .. .. | 3,916,000 .. .. | 3,724,000 |
| 1923–24 .. .. .. | 6,103,000 .. .. | 1,817,000 |

As a result of the stocks of manganese ore existing at the works of the Southern Steel Trust the inland demand has not developed. For the present year ended with next September the production of the first quality of ore, which is sent to foreign markets, is estimated at 6,000,000 poods, or, 96,000 tons in round figures, and having a manganese content of about 48 per cent. The home demand for this quality in the same period is calculated at 2,800,000 poods, or 45,000 tons. The stocks of ore in this region are slightly less numerically than those in Chiatur, but are inferior qualitatively.

The sale price of Nikopol ore delivered free at the port of Nikolaieff is 48.5 copecks per pood, thus yielding an exceptional profit.

The total exports from the two regions in the present fiscal year are estimated at 33,500,000 poods, or nearly 539,000 tons.

Mr. Sverdloff states that a considerable increase in the exports of manganese ore over the proposed quantity would lead to a fall in the world's prices. As a consequence the future possibilities of earning good profits would thereby be prejudiced, and he, therefore, suggests that the exports should be skilfully regulated in the future and efforts made to reduce the costs of production in competition with the ores of India and Brazil.

### THE SITUATION OF IRON ORES.

As mentioned earlier, the economic results arising from the export of iron ore are far from being so satisfactory as those resulting from the exports of manganese ore. Nevertheless Mr. Sverdloff considers that the export of iron ore is desirable having regard to the stocks existing from old production, which represent dead capital lying in the stores of the Southern Trust, and the necessity for procuring working funds for the development of the work of this trust.

The stocks of iron ore at the mines of the Southern Mining Trust on October 1st, 1924, amounted to 65,000,000 poods, and those at the works of the Southern Steel Trust reached 20,000,000 poods on the same date, while the production in the current financial year is computed at 70,000,000 poods, making a total of 155,000,000 poods. The consumption of the Southern Steel Trust and of other consumers is estimated in the present fiscal year at 58,000,000 poods, the ore reserve stocks in case of transport troubles at 47,000,000 poods, so that the possible quantity available for export would be about 50,000,000 poods.

The cost of producing Krivoi-rog ore is 8.075 copecks per pood franco at the mines. It is possible to send the ore overland through the station of Zdolbunovo or by sea through the port of Nikolaieff. In the first place the price franco Zdolbunovo equals 21 copecks per pood, and the costs amount to 18.475 copecks—8.075 copecks plus 10.4 copecks as the expenses of transport—that is to say, the profits per pood of ore are about 2.5 copecks per pood.

Regret, however, is expressed that it is quite impossible to export deliveries of the ore by way of Zdolbunovo, since the Polish market at present is of insufficient capacity to absorb it. On the other hand, and until the reduction in the railway rates for the transport of the ore to the port of Nikolaieff there was a loss of 2.5 copecks per pood, but as the rates from the station of Vechernie Kut to that port have just been lowered, the loss on exports has been brought down to about 1.1 copeck per pood.

However, in the opinion of Mr. Sverdloff, this loss can be diminished in case measures are adopted to reduce the expenses connected with the loading and discharging operations. These expenses represent, for instance, 3.37 copecks per pood of ore, of which the discharging of the wagons forms 0.85 copeck, loading on ship 1.185 copeck, the charges for the use of the loading plant 1.250 copeck per pood, and rent of stores and Customs charges 0.082 copeck. It is considered to be obvious that these charges are excessive, and that it would be possible for them to be reduced to at least 1 copeck, when the export of ore by way of Nikolaieff would cease to result in a loss.

The successful solution of the problem of the export of Krivoi-rog ore is regarded as being quite an important matter as an improvement in the exports of the Southern Trust, which works both for the home and foreign market, would render it possible for the trust to develop and cheapen its production in consequence of which the home iron industry would be able to have iron ore at lower prices.

A few words may be said in conclusion. The Southern Mining Trust exported some 450,000 poods of iron ore in the fiscal year ended with September 30th, 1924, which quantity is considered to be absolutely unsatisfactory, and it is held to be necessary for efforts to be made to expand the exports. In the case of manganese ore the favourable situation of the world's markets permitted the Russian trust to earn large profits, although the exports of this sort only amounted to 1,817,000 poods in the same year, so that it is considered that energetic measures ought to be taken to develop the exports of manganese ore.

## JUNIOR INSTITUTION OF ENGINEERS.

AN interesting discussion on the subject of "Inverted Tooth-chain Drives" followed a lecturette delivered before the Junior Institution of Engineers, by Mr. J. M. Seddon, A.M.I.E.E., on Friday, February 20th. Opinions were expressed as to when a chain drive would be more suitable than a belt drive, and on the question of cost Mr. H. V. Pointon said that in many cases he had found that the cost of a chain and two pinions was less than that of a belt and two pulleys. Mr. Seddon pointed out that a chain drive should be designed with reasonably short centres from considerations of weight. The weight of a 3in. pitch chain was, he said, about 40 lb. per foot length. If a long drive were necessary, then it was not a case for a chain. Mr. F. E. Squirrel inquired if there was any rule as to whether the slack side should be on top or at the bottom, and also suggested that tooth chains were liable to become clogged if they worked in a dusty atmosphere. Mr. Seddon said that it did not matter much whether the slack side was on top or below, but that with very short centres and a very big reduction it was better to have the slack side at the bottom. If it were on top there would be a liability to stick. Dust would be a nuisance unless the chain were cased in. Mr. A. P. Long said that even more precautions were necessary in a glass works, where rouge found its way everywhere. In reply to Mr. R. H. Allen, Mr. Seddon said that the rocker pins were case hardened till they were almost glass hard, and the ends were then softened in order that they could be tapped over when the pins were in position in the links. That was the way in which the pins were secured. Mr. Seddon having stated in the lecturette that the sprocket wheels, which were made either of hardened steel or cast iron, would outlast two or three chains, Mr. Petree asked whether, on renewal of a chain, one of slightly increased pitch were used. To that question Mr. Seddon replied that it was not very good practice to put new chains on old sprockets, though it was often done. The wear on the teeth was very little, and therefore it was not necessary to increase the pitch.

# Provincial Letters.

## THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

### Trade Position.

THE Midland iron and steel industry continues depressed, just sufficient business cropping up week by week to keep plants in operation. The month just passed has done little, if anything, to brighten the outlook, yet there are still to be found optimists whose confidence in the ultimate recovery of business has not been shaken. They still assert that such recovery cannot be long delayed in view of the need for material for a wide variety of uses. With weakening prices, there is no disposition to book orders in advance. Consumers are buying only for immediate needs, and in those branches of manufacture in which iron and steel are most largely used, the rate of consumption is so low that the market is inevitably over supplied, notwithstanding the measures taken to curtail the output of raw material. In the Staffordshire iron trade the position is unchanged, producers of bar iron experiencing considerable difficulty in keeping their plants in operation.

### Raw Iron Prices.

Midland pig iron continues to depreciate in value despite the strenuous efforts of many furnaces to stop the downward movement. On 'Change in Birmingham to-day both forge and foundry sorts were fully one shilling per ton cheaper than a week ago. Derbyshire No. 3 foundry was quoted £3 19s. to £4. Northamptonshire £3 14s. to £3 15. For Derbyshire forge £3 15s. to £3 16s. was asked, and for Northamptonshire £3 9s. to £3 10s. To give some of the prices stated to be acceptable to a few nervous smelters anxious to find outlets for their production would convey an exaggerated impression of the depreciation. Though quotations are being substantially cut in special cases, values have not given way as a whole to the extent these concessions might suggest. There appears to be little disposition on the part of consumers to renew expiring contracts, and it is a disquieting feature that their expiry does not perceptibly augment the volume of the hand-to-mouth buying. What prices smelters would accept in their present situation for a really big order is a matter for speculation, for no big orders are on the market. Business in forge and basic pig iron is dull; and the market in foundry grades is inactive, though it is better than in the departments mentioned. Blast-furnace coke is not difficult to obtain, and values, with a few exceptions, appear to be fairly well maintained. Occasionally a bargain lot can be bought below the 16s. 9d. basis, but prices, on the whole, are steady.

### Steel.

There is little change in the steel situation on the week. Day to day orders are still coming along in considerable number, but there is practically no forward buying. Certain branches of the general engineering industry continue fairly brisk, and the call for constructional material shows some slight improvement, but the whole position is uneven. Values generally are irregular, and tend to weakness, though there has been no definite lowering of quotations. Angles and joists can, however, be obtained round about £8 15s., while small bars rarely command more than £9 per ton. The demand for plates does not improve. In the semi-finished department producers have increased difficulty in disposing of their output, and mild steel billets are obtainable at cut prices. Though many Midland makers continue to ask £7 5s. ample supplies are on offer at £7. Foreign steel is not being pressed on the market quite so keenly. The Belgian works are reported to be well furnished with forward bookings, and the latest information is that prices are not likely to further recede, although plenty of cheap material is still available. The instability of the franc deters business in continental supplies, but there is little reflex in prices as yet. The scrap marekt remains dull. Indeed, steel scrap is scarcely saleable. Users are pressing for price reductions, offering fairly large contracts on the basis of lower prices.

### Finished Iron.

The Staffordshire finished iron industry continues quiet, with the exception of marked bars, in which trade continues on a comparatively good basis at £15 per ton. Fortunately there is every probability that this high-class material will continue to be required in more or less large quantities for such special uses as anchor making and various engineering requirements, in which the high quality and special characteristics of marked iron are valued. Business in other grades of finished iron is disappointing. The quotation of £12 15s. for Crown quality bars is still given, but orders have been taken at a few shillings below this figure. The Staffordshire nut and bolt manufacturers are buying sparingly of British iron, many having still in stock good supplies of Belgian material. Imports from Antwerp on contracts made some time ago at very low figures are considerable. Many mills continue to be engaged in re-rolling of continental steel.

### Cheaper Sheets.

The fall of 5s. to 7s. 6d. per ton in 24-gauge galvanised corrugated sheet prices is attributed to a scarcity of work at many of the Midland mills, and a desire to keep plants going. Sheets were obtainable on 'Change in Birmingham to-day—Thursday—at £16 12s. 6d. f.o.b. Liverpool, though some rollers quoted £16 15s. For a desirable specification it is stated several mills are prepared to take 2s. 6d. per ton below even these prices. Activity is well sustained as regards the lighter gauges, though consumers can get deliveries with less delay than they had to provide against a little while ago.

### Ironmaster's Plea.

Mr. S. S. Somers, chairman of Messrs. W. Somers and Co., of Haywood Forge, Hales Owen, on Saturday last, in speaking of the position of the iron and steel trade, said that something must be done quickly to alleviate the tremendous amount of unemployment that now existed. Those who were interested in the iron and steel trade knew perfectly well that that industry was in a worse position to-day than it had ever been. More blast-furnaces were closed down than had ever been known before, but although the iron and steel trade was in such a bad state, a large amount of imported steel was being used in this country. Something like 2¼ million tons of steel were imported last year, and if that steel had been made here it would have provided work for 100,000 men, and it would have absorbed about 7,500,000 tons of coal. That would give them some idea how the coal trade, which they were hearing so much about, would have been improved. What the iron and steel trade and other industries that were subjected to unfair competition needed, was the little bit of protection that the Government seemed to hesitate about.

### Output Must Be Maintained.

The importance of maintaining output in the rolling stock industry was emphasised by Mr. Alfred R. Windle, chairman of the Birmingham Carriage and Wagon Company, Limited, at the annual meeting of the company last week. Depressed conditions prevail, he said, in the, large industries of the country, shipbuilding, iron, steel coal, all of which reflect their depression upon the rolling stock industry. The whole question of prosperity and success in the future lay in maintaining output. A restricted output, from whatever cause it arose, whether it be a stoppage like the nine days' national stoppage on the railways last year, or whatever cause it might come from, would militate very largely against anything like successful trading. They must have output, and that really rested with the workers of the country. They could not reduce overhead charges beyond a certain point, but by increasing output they could reduce them, and at the same time provide an opportunity of giving employment to additional workers.

### Pullman Car Contract for Birmingham.

Orders for six new Pullman cars, specially designed for the Southern Railway Company's services between London, Tunbridge Wells and Hastings, have been awarded by the Pullman Car Company, Limited, to the Metropolitan Carriage, Wagon and Finance Company, Limited, of Birmingham. The cars, which will each have a length over buffers of 65ft. 10in., a width overall of 8ft. 8in., and a height from rail level to the top of the elliptical roof of 12ft. 7in. An important innovation will be that these new Pullman cars will be vestibuled to the other vehicles of the train, and meals and light refreshments will be available to both first and third-class passengers in the ordinary train vehicles, without the supplementary Pullman charge, and folding tables will be provided for this purpose in the compartments.

### Rolling Stock.

The following contracts have been given out by the London and North-Eastern Railway Company to Midland firms. Midland Railway Carriage and Wagon Company, Birmingham, 23 carriages and three complete suburban trains; Metropolitan Carriage, Wagon and Finance Company, Birmingham, 49 carriages and one suburban train; Birmingham Railway Carriage and Wagon Company, 24 carriages; the Gloucester Railway Carriage and Wagon Company, 10 carriages.

### Cannock Chase Miners' Wages.

The wages of the Cannock Chase miners are reduced 1.19 per cent. for the month of March. This is equal to a decrease of 1d. per day on the minimum wage of stallmen, which now will be 10s. 4d. per day. The wages for March are based on the coal output and on selling prices for the months of November, December and January.

### Midland Workless.

Unemployment in the Midlands continues to decrease, the latest return of 137,762 being 2735 less than the previous total, and 6183 less than the return of a fortnight ago. During February the payments decreased by the substantial figure of £16,000. On the week the returns for Greater Birmingham show a decrease of 429, the total figures being 29,437, compared with 29,866 last week. Of the total 28,234 are wholly unemployed, and 1203 on short time. The Coventry total is 1395, against 1400 a week ago.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER.

### General Outlook.

IT is considered here that any expectation of an improvement in the Lancashire markets this spring may now be dismissed altogether, and the iron and metal trades may be very well satisfied if the present moderate volume of business can be kept up in the district. It is fairly clear now that the cotton trade, which is, of course, the foundation of Lancashire industrial prosperity, is unable to revive as was expected; and that the larger profits which it was hoped would be used to buy new textile machinery are not being made. This chance of revival in the engineering and foundry trade may therefore now be dismissed for the present. The expectation of improvement through the distribution of railway orders is also disappointed here; and many people are surprised that so little beneficial effect is produced by this cause. So far as Manchester is concerned, the railway orders reaching the district are a mere drop in the bucket. One hears of them occasionally; but spread as they are over the whole country, they seem to be negligible.

### Metals.

The dullness of the metal markets comes as a damper on the hopes of those who thought that non-ferrous metals, and especially copper, were at safe prices. As a matter of fact, one cannot expect any serious fall in copper prices; but what was hoped for was a considerable rise, and this now seems as far away as ever. It is clear that there has been a considerable expansion in the consumption of copper, and it seems probable that this is still going on. Last year, for instance, the consumption of copper in Great Britain was some 40 per cent. greater than it was in 1923; but apparently copper producers in the United States have been increasing their output to a corresponding degree. One fears that the producers have been going too fast, and that unless a halt is called there can be no satisfactory improvement in the market. What the trade needs is such a confidence in copper prices as will induce all consumers to hold substantial stocks, and this desired confidence is further off than before. Something might be done to stimulate copper consumption if the difference between refined copper and its manufactured forms—sheets, tubes, &c.—could be reduced. Manufacturers, however, seem still to prefer "small business and large profits" to large business and small profits. Meantime, the manufacturing engineer has to pay fancy prices for a good deal of the metal which he needs. There has been a serious slump in the market for tin this week, and it is not at all easy to find out the reason. Tin dropped to £250 per ton, and perhaps some reaction is only to be expected. The January statistics of the American tin-plate trade are not so favourable, but it is still hoped that the tin consumption there will increase. No very definite view as to the price movements is being taken here, and both merchants and consumers had been expecting a much steadier market than is usually the case with tin. The fluctuations in February were confined within about £5 per ton, whereas those in January showed a £20 variation. Lead has been a fairly steady market, and the slump in prices does not yet seem to be near; but some attempts are being made to find substitutes, and the high prices are stimulating attempts to discover and work fresh lead properties. In the end a fall must come, but the end is not yet. Spelter is a steady market, and shows very little change.

### Pig Iron.

The demand for foundry iron in Manchester shows no sign of enlarging at the moment. The transactions reported are almost all for small lots of from 10 to 50 tons, and the prices are round about 87s. 6d. for Derbyshire and for the Staffordshire irons, with one or two small lots of Lincolnshire at about 89s. The latter is, of course, quite a scarce iron here now. Northamptonshire iron is at about 86s. 6d. delivered here, but one does not hear of any inclination to buy it. Consumers here seem fairly satisfied that there is no danger in working upon a small quantity of stock, and relying upon being able to buy at the present prices or at a little less whenever they want iron. This, of course, means that the trade is mainly retail, and it also means that quotations for castings are frequently cut under the belief that iron may be cheaper when the order has to be put in hand. That there can now be very much cheaper iron in this district seems improbable; for even if the Cleveland price should be brought down to 75s. on trucks, it will still be, so far as Manchester is concerned, as high as Derbyshire is at the present moment. All that would be necessary for the Derbyshire makers, in order for them to keep control of this market, would be a concession of 6d., or at most of 1s. per ton. The demand here for Scotch iron remains very small, and the nominal prices range from 104s. to 105s. 6d. per ton, but less has been taken.

### Steel.

There seems to be further weakness in the market for heavy steel, such as plates and sections, although lower prices are not readily admitted either by the works or by the merchants. The orders coming in are few and far between, and there is the keenest competition for them. Steel makers in the northern Midland district do not like the idea that the Scottish works are able to compete with them, notwithstanding the difference of carriage. Of course, the theory is that such business must be taken at a considerable loss, but perhaps the Midland works have not yet economised so drastically as the Scottish works. In any case, steel plates have been offered here down to £9 7s. 6d. per ton and heavy steel sections down to £8 12s. 6d. The continental prices are again reported weak, the f.o.b. price for joists being £5 12s. 6d. and for plates £7 7s. 6d. per ton.

### Scrap.

There is practically no change in the scrap market this week. It is hoped that the depression is at its worst, but one is doubtful whether any revival can be near at hand. Dealers here seem rather pessimistic, especially with regard to heavy steel melting scrap, for which they are scarcely inclined now to pay 65s. per ton. Cast scrap for the foundry is nominally at 80s. to 85s. per ton, according to quality, and wrought scrap for the forges is at about the same figure.

### Institution of Electrical Engineers.

The annual dinner of the North-Western Centre of this Institution was held at the Midland Hotel, Manchester, on Friday, the 27th ult., the chairman of the branch, Mr. H. C. Lamb, presiding. There was a record attendance of members and friends, including Mr. W. B. Woodhouse, President of the Institution; Mr. Austin Hopkinson, and Dr. S. Z. de Ferranti. In proposing the toast of "The Institution of Electrical Engineers," Mr. Hopkinson made one of his characteristic speeches with reference to the Wireless Bill and the Trade Union Levy Bill, both of which he criticised adversely. He said the former introduced some remarkable principles, but it was drafted so ambiguously that it ought never to become an Act of Parliament. It could be better dealt with by members of the Institution of Electrical Engineers. Mr. Woodhouse replied to the toast. With regard to the Wireless Bill, Mr. Woodhouse said the Council had represented to the Government that it could put forward a reasoned criticism of the Bill. The toast, "Our Guests," was undertaken by the chairman, Mr. Lamb. Referring to the chief guest, he said that Mr. Woodhouse was the first North

Country engineer who had been made President of the Institution, Mr. Austin Hopkinson was the leader of a parliamentary party of one, and the Lord Mayor (Alderman F. J. West) was a gas engineer who had rendered excellent service for about sixteen years on the Electricaity Committee of the Manchester Corporation. The toast was responded to by the Dean of Manchester. The arrangements for the function were carried out very effectively by the honorary secretary, Mr. A. B. Mallinson.

### Manchester Electricity Undertaking.

Mr. S. L. Pearce, M. Inst. C.E., the chief engineer and general manager of the Manchester electricity undertaking, who has just returned to this country after a visit to Australia, where he has been advising the Corporation of Sydney with regard to the local electricity supply scheme, was entertained last week by the Manchester Electricity Committee in recognition of his twenty-one years' service as head of the department. He was presented with a "grandfather" clock from the Committee, a silver tea and coffee set and cut glass bowls from the staff. Speaking of the Manchester works, Mr. Pearce said it might not be long, probably about the end of the year, before they would have to consider the question of a further installation at Barton, and in the distance he could see the Carrington station looming up. At Carrington they would be near neighbours of the great gas station at Partington.

### The Industrial Motor Vehicle Industry.

At a meeting of the shareholders of Leyland Motors, Limited, held at Leyland on Wednesday, the 25th ult., the chairman, Mr. John H. Toulmin, speaking of future prospects, said that probably the largest development in motor transport in the immediate future would be concerned with passenger-carrying vehicles. It was anticipated that new regulations governing the use of motor vehicles would be issued at an early date. The Leyland Company, he said, had developed and was developing certain passenger-carrying vehicles which would comply with the altered conditions. Further developments in motor omnibus services by municipal authorities might be expected. Many tramway undertakings were now running motor omnibus services, and some had decided to seek powers gradually to discard the tramway track and substitute the more flexible type of vehicle. Mr. Toulmin said that last year's output of the Leyland works included 1788 commercial vehicles, and the turnover was £1,877,000. Last year 19 per cent. of the machines which the company built were for use overseas.

### A Confident Outlook.

Speaking at a meeting of the shareholders in Mather and Platt, Limited, held last Friday, in Manchester, Mr. Loris E. Mather, the chairman of directors, said there was still much uncertainty with regard to the future, but the company had started the year well. With more settled conditions on the Continent of Europe, they were looking forward with confidence to improvements in many of the markets which had since the war been of little benefit to them. The firm's home trade was quite good last year, and continued to show an increase, while there was a steady flow of orders from India, Egypt and the Far East. More inquiries were coming from South America, too. Speaking of the firm's domestic affairs, Mr. Mather said their relations with their workpeople throughout the year had been of the happiest character. This he attributed in no small measure to the works committee which met once a fortnight and discussed freely and openly any difficulties or misunderstandings which arose, before they had time to become serious. He said he was sure that if the directors of every engineering works in the country would realise that a works committee ought to be an essential part of their organisation, there would be less heard of restriction of output and other similar troubles.

## Barrow-in-Furness.

### Hematite.

There is no change in the hematite pig iron trade, and it is not anticipated that there will be any for some time. It may be that the Budget will have to be thoroughly digested before buyers make a move. The thirteen furnaces in blast in the north-west district are practically clearing their output, but it must be remembered that the steel works at Barrow and Workington are taking a pretty large portion of that output. But for that fact there would have to a serious reduction as regards ordinary mixed numbers. The Scottish and Midland trade continues to be without feature, and there has been no sign of improving demand—rather the other way, if anything. The continental trade is dull, but the American business continues and a part cargo was shipped from Barrow last week to Philadelphia. The trade at present is for immediate requirements. The demand for better qualities is poor.

### Iron Ore.

The iron ore trade continues in about the same condition. The restricted demand from consumers outside the district is small—smaller than it was three months ago. Foreign ore is arriving in moderate quantities and stocks exist in the district.

### Steel.

The steel trade is not very lively, but the rail mills at Barrow are still engaged. Fresh orders would be welcome, although the run of this department has been longer than was at first anticipated. The rail mills at Workington are engaged this week, and are likely to run next week as well. Other mills at Barrow, such as the hoop and small section, are fairly well off for orders.

### Engineering.

The engineering departments at Vickers' works keep fairly busy on their post-war products. Orders for parts of the Vickers-Spearing boiler are continually being received. These boilers are erected on the job, and this branch of activity has developed considerably. What was the new shell shop is now devoted to the construction of special plant connected with the new system of firing by means of pulverised coal.

## SHEFFIELD.

*(From our own Correspondent.)*

### Iron and Steel Depression.

Of the many branches of the iron and steel industries, the worst conditions are at present being experienced by the heavy departments. Since the spurt towards the close of last year the market has been gradually falling, and at present it must be confessed there is no evidence of a turn for the better. The blast-furnaces in Lincolnshire and Derbyshire, and the open-hearth steel furnaces in the Sheffield, Rotherham and Parkgate areas are all complaining that they are producing in excess of the demand. Users of crude and semi-finished materials are content, with what supplies they have in hand, to buy within the narrowest margin. Though deliveries of foreign billets are still being accepted, there are signs that this competition is becoming less severe. Producers of acid steel are the most favourably placed, the call for railway material being consistent. The contracts for the home companies are being proceeded with at a steady rate, and this source of work is proving of particular value to Sheffield at the present time. Every effort is being made to get more foreign business, but without any great success so far. The rolling mills are deriving most of their activity from sheets and hoops, the former giving promise of steady business for some time ahead. The heavy forges and foundries, except for a little armament work, are not attracting much business.

### Lighter Steel Trades.

Conditions are better in the finished than in the crude departments, but they are far from being prosperous. The general complaint is that orders are not coming through freely enough. Business, in fact, is showing signs of curtailment and quotations are on a strictly competitive level. The home and Colonial markets continue to call for fairly satisfactory quantities of the best grade tools, but the foreign trade is insignificant, only attracting specially situated customers. Ordinary foreign business in the tool departments is extremely difficult to secure owing to the keenness of competition and the comparatively high prices of the Sheffield products. Land tools are experiencing a brisk market at the moment with contracts in hand, but it looks as though the season's needs are now almost met, as fresh orders are arriving more slowly. Saws and files are steady lines, though a good deal more work could be accepted to bring the output up to full capacity.

### Cutlery and Plate.

Although the output of these trades is substantial the position cannot be described as satisfactory. In the first place competition to get business is so keen that price cutting is being indulged in, particularly by small firms, which, with small overhead charges, are able to run their works much more cheaply than the big firms. The latter, too, refuse to concede anything in the way of quality. Output of both plate and cutlery is still below what it was towards the end of last year, and although catering and hotel firms are placing contracts for knives, forks and spoons, the general sales to the public through the wholesale and retail houses have not recovered their average standard. There should be an improvement in this department shortly. The best of the Colonial markets is Australia, but there is an improvement in India, and Canada and South Africa are inquiring more freely and would obviously buy on a more liberal scale if they could afford to do so.

### Electricity Developments.

Several districts are paying attention to electricity matters, and important developments are pending. Nottingham City Council, for instance, has decided to add 20,000 kilowatts to the generating plant now being put in at the new station at North Wilford in connection with the East Midlands electricity supply scheme. Already three 10,000-kilowatt sets are being installed at a cost of £684,000. The estimated cost of the additional works is £292,000. The Electricity Commissioners have been asked to receive a deputation from Retford Council to urge the necessity of an immediate decision of their application to install a generating station for the supply of electricity to the borough and district. The Commissioners, it is stated, are unwilling to allow any authority to generate electricity if current could be supplied in bulk from some other source. Negotiations are stated to be taking place between Worksop and the Derbyshire and Nottinghamshire Electric Power Company regarding a supply in bulk.

### Sheffield Weekly Exchange.

It is now fifteen years since the Sheffield Exchange—coal, iron, steel and allied trades—was formed, and that it is continuing to fill an important place is shown by the fact that the membership has reached a higher figure than ever before. The official handbook will shortly be published, and in an interesting article in it, reference is to be made to the enormous developments that are taking place in the coalfieds around Sheffield, which is taken to indicate that there is still wider scope for the activities of the Exchange. The prophecy is made that North Nottinghamshire bids fair to become a rival to South Yorkshire in the production of coal. The community of interest between Sheffield and North Nottinghamshire is very strong; there is reason to believe that it will be maintained and strengthened by the development of the new coalfield, and that the Sheffield Exchange will gain added importance and significance as the nearest market of the newest coalfield. In face of these statements it is interesting to recall the gloomy view taken by many when the formation of the Sheffield Exchange was mooted, and when it was contended that the facilities afforded by Leeds, Birmingham and Manchester were adequate.

### Scarborough Harbour Scheme.

The scheme for improving the harbour at Scarborough at a cost of £45,000 has been accepted by the authorities, and was reported on at the half yearly meeting of the Harbour Commissioners. The matter is still in an indefinite stage, however, over the question of the amount of Government grant to be made. In its accepted form the scheme provides for the deepening of a large area of the old, or inner, harbour from the fish market to the Sandside, to a depth of 3ft. below low water level of ordinary spring tides. A wharf is also to be built along Sandside extending alongside the deepest portion of the harbour. Vessels will then no longer be limited to landing fish at the West Pier.

### New Gas Plant.

New carbonising plant at Chesterfield Municipal Gasworks has been installed, exactly a hundred years after a company built the original works. The new plant has cost £22,000. Forty-two inclined retorts are replaced with sixty of the horizontal type, complete with coal conveyor and bunkers, retort charging and discharging machinery, coke 'bus for filling furnaces and loading skips, telpher and track for moving coke from retort house to screens and hoppers, complete screening plant for coke on rails, with over six elevated ferro-concrete bunkers for storage and loading purposes. The new plant will produce 1,200,000 cubic feet of gas per day on the most economical lines. The production of gas at Chesterfield has been almost doubled in the last eight years.

### Another Cathedral Problem.

A report on the condition of Lincoln Cathedral has been submitted by Sir Francis Fox, engineering adviser, and Mr. R. S. Godfrey, surveyor and clerk of works at the Cathedral. Serious discoveries have been made recently. In the North-West Tower it has been found that the core of the oak timbers has been eaten away by the deathwatch beetle. An entire new timber roof will be required for this tower. When the floor boards in the clock chamber of the Central Tower were lifted such wide cracks were revealed as to show that the vaulting of the lantern, which is only a brick thick, is actually supporting the keystone of the arch.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Iron and Steel Export Trade.

The position in the North of England iron and steel trade with regard to foreign business is still disappointing, but it is certainly better than at the beginning of the year, and hopes are entertained that the current month will see a marked improvement. At all events, we are getting down to a figure at which we can compete for continental business, and already there are a few more inquiries. Thus at the beginning of March the outlook may not be quite so gloomy, but the returns of the export trade from Cleveland for February reveal absolutely no advance on the disappointing figures for January. The most that can be said is that with three fewer working days, the February volume of exports is up to the January standard, a slight decline in the coastwise shipments, both of pig iron and manufactured iron and steel being compensated by a trifling improvement in the foreign trade. Compared with 17,959 tons of pig iron shipped to coastwise ports from Cleveland in January, 12,407 tons were shipped in February, but the foreign shipments went up from 13,227 tons to 15,326 tons. Belgium, France and Italy all took increased quantities of pig iron, but these advances were offset by smaller shipments to Germany and Scandinavia. Coastwise shipments of manufactured iron and steel totalled 17,703 tons in February, as against 17,879 tons in January; but whereas the foreign shipments in January were 34,870 tons, they advanced in February to 36,694 tons. Thus the aggregate shipments of pig iron, manufactured iron and steel, which totalled 81,935 tons in January, reached 82,130 tons in February, though there were three fewer working days.

### Iron and Steel Imports.

A substantial increase in the imports of crude bar sheets, billets, blooms and slabs into the ports of Middlesbrough and Stockton was revealed in the statistics presented at this week's meeting of the Tees Conservancy Commissioners. Since November the total imports from Holland, Belgium, France, Norway, Sweden, Germany, India and coastwise have totalled 40,166 tons, as compared with 16,181 tons for the corresponding period of 1923–24. During the past month 8624 tons were imported. Pig iron imported in the past four months amounted to 3947 tons against 6126 tons a year ago, and 54 tons in the pre-war period. During last month 263 tons were received, as compared with 4435 tons for the same period in 1924. From November up to the end of February, 7513 tons of plates, bars, angles, rails, sheets and joists were imported, as against 4456 tons a year ago, and 7906 tons in 1913–14. The imports of these materials during February reached 3777 tons.

### Cleveland Iron Trade.

The Cleveland iron market still displays a weakening tendency. The position is not actually devoid of hope, but the volume of business actually arranged is still very limited, and anxiety over the disposal of current output is still forcing prices downward. There seems to be a little more inquiry from Scotland, where consumers are finding existing contracts nearing the point of exhaustion, and fresh inquiries are to hand from Germany, where, unfortunately, heavy dock dues and costs of discharging tend to hold up imports from this country. However, there seems to be some hope that further business may be arranged. Still, it is the restricted export trade which very largely contributes to the present weakness of the

market, and although 78s. 6d. per ton remains the nominal quoted price of No. 3 Cleveland pig iron, 78s. has been accepted. No. 1 remains nominal at 83s. 6d., No. 4 foundry 77s. 6d., and No. 4 forge 76s. 6d.

**Hematite Pig Iron.**

The demand for East Coast hematite pig iron is still slow, and competition for orders is as keen as ever. Even yet the downward movement has not been arrested, and the quotation of 85s. for mixed numbers and 85s. 6d. for No. 1 represents a drop of 6d. per ton on the week.

**Ironmaking Materials.**

The foreign ore trade is lifeless, but sellers decline to cut below 22s. per ton for best Rubio ore c.i.f. Tees. The price of good medium furnace coke is unchanged at 24s. per ton delivered at the works.

**Manufactured Iron and Steel.**

The manufactured iron and steel trade is badly in need of new business. Only small orders are being placed, and this fact adds to the difficulties of makers in arranging their rolling programme. Nevertheless, prices are kept firmly at recent levels, only galvanised corrugated sheets being inclined to droop.

**Coal Trade Slump.**

The serious depression in the Northern coal trade is shown by the joint reports of the accountants regarding the proceeds and costs in the coal-mining industry in Northumberland and Durham during the months of November, December and January. The latest ascertainments would regulate wages during the present month, but for the operation of the minimum clause in the national agreement. The figures clearly indicate the low level on which miners' wages would be if the men had to depend solely on what the coal would bring in the open market. In Northumberland the figures of proceeds and costs show that the wages in March would be at the rate of 64.74 per cent. on basis wages, as compared with 69.30 per cent. in February, or a reduction of 4.56 per cent. The minimum rate of wages in the county is 100 per cent., and thus the earnings payable in the current month are over 35 per cent. more than the proceeds and costs would really yield. The decline in the Northumberland coal trade has been most marked for over a year. In January of last year wages stood at 124.85 per cent. on basis rates, whereas they now stand nominally at 64.74 per cent. In Durham county the ascertainment shows that the wages this month would have been 81.83 per cent. of the basis as compared with 86.85 in February, a reduction of 5.02 per cent. The miners are protected by a minimum of 110 per cent. in this district. In January last year Durham wages stood at 120.40 per cent. on the basis.

**The Coal Trade.**

Not the slightest improvement is noticeable in the Northern coal trade, and the position, in fact, is regarded as being more depressed than ever. The representatives of local exporters returning from visits to Holland, Belgium and Germany all have similar reports to make—an almost total lack of buying of British coals, and a superabundant supply of German coals at substantially lower figures than Durhams or Northumberlands. The outlook ahead is very disappointing, and very few operators anticipate any substantial improvement for some weeks to come. In addition to many pits already closed, steps are being taken to close down further collieries, and large bodies of men have received notice; but, in addition to this temporary closing down, there is a great deal of idle time, and at many pits work is suspended from day to day. The lack of inquiry gives no encouragement that any increased output will be needed for some weeks. While operators are doing their level best to keep a cheerful countenance, and eagerly searching for additional orders, the position gives little expectation of any early improvement, and the most that can be hoped appears to be that the present low volume of demand will not become less. With no special inquiry for any grade or from any direction, sellers ask recent prices, and maintain that even concessions on the present low range of prices would not bring anything additional on the market. The only hope is to await a general revival of trade throughout the Continent, and this is regarded as improbable until the general range of working costs is substantially reduced. The coke trade is as depressed as the coal section, the demand being slow and stocks plentiful. Prices remain easy.

## SCOTLAND.

*(From our own Correspondent.)*

**Clyde Shipbuilding.**

So far as the condition of the shipbuilding industry is concerned, the output returns from the yards for February are somewhat misleading. The output is well up to the average for pre-war years, and apparently indicates a fair measure of prosperity, but unfortunately the number of contracts for orders for vessels to occupy the vacated berths is wholly inadequate. Contracts for special vessels and general carriers have been reported, but there is an absence of orders for large passenger ships. Builders have considerable difficulty in quoting sufficiently low prices while the uncertainty of the labour situation is ever present. During February twelve vessels of 40,936 tons aggregate were launched from Clyde yards, the chief being as follows:—Alaunia, twin-screw turbine, 14,000 tons, for the Cunard Line; Baron Fairlie, cargo, 6665 tons, for Hugh Hogarth and Sons, Glasgow; Elmbank, t.s. motor ship, 5200 tons, for Andrew Weir and Co. (the Bank Line), Glasgow; Cape of Good Hope, motor cargo vessel, 4700 tons, for the Lyle Shipping Company, Glasgow; Aukling, passenger and cargo vessel, 3700 tons, for the China Navigation Company, Limited, London; St. Julien, t.s. geared turbine, 2000 tons, for the Great Western Railway Company, London. New orders include a cargo steamer of 9000 tons and four of 5500 tons, all for Glasgow owners, two cargo steamers for the Southampton–Havre service of the Southern Railway, and a turbine steamer for the Dover–Calais service of the same company.

**No Improvement.**

The general situation in the steel, iron and coal trades is unchanged, and prospects are not encouraging, to say the least of it. Markets are dull in the extreme, and despite the efforts of producers, exporters and others, business on all hands continues within meagre limits. Foreign competition still provides the chief stumbling block. Home makers have repeatedly endeavoured to meet buyers in the matter of price, but the terms quoted abroad for similar material constitute too great an opposition. Production costs at home evidently eliminate any hope of immediate relief in the nature of further substantial reduction in price, and it therefore seems to be a matter of waiting until foreign prices come more into line with the home figures.

**Steel and Iron.**

The only satisfactory feature in the steel trade is the continued demand for light, black and galvanised sheets on foreign account. Producers of these goods have fair orders on hand, and inquiries still come to hand with regularity. A firm level of prices is therefore maintained. Heavy sheets are not so prominent. Plates are only obtaining pickings and sectional materials are little, if any, better off. The difficulty in securing tonnage from week to week is ever present, and mills are moving very slowly. The same conditions are met with in the bar iron industry, business in the aggregate being far below normal. The re-rolled steel branch of this industry has occasional good lines, but for the most part it is as quiet as the bar iron trade. Re-rolled steel bars are quoted in the region of £8 10s. to £9 per ton, home or export.

**Pig Iron.**

The pig iron market is more or less stagnant. Orders from steel works are meagre, and hematite shows little movement. Foundry qualities are no better off, and the curtailment of outputs is being carried further, as stocks in makers' yards are still on the increase. The tone of the market is dull and tends to become easier.

**Coal.**

Nothing of particularly fresh interest has occurred during the week. Lanarkshire prime splints maintain the distinction of being the exception to the general rule of inactivity, but even for that description of fuel the demand shows signs of easing off. Despite the stoppage at several pits, the accumulation of fuel is still very evident, and it is probable that the majority of the notices posted announcing a temporary stoppage will be put into effect. There is no sign of any increase in foreign orders on either prompt or forward delivery, and most sorts of large coals are extremely difficult to sell, even when prices are cut to the limit. Washed materials are in an even worse plight, and treble and double nuts are very weak. Shipments for the week amounted to 231,475 tons, against 248,816 tons in the preceding week and 256,691 tons in the same week last year.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**Coal Trade Position.**

THE steam coal trade has undergone no great change since writing a week ago, and the conditions all round are very quiet. Even the Blackpool conference of miners' delegates has failed to do anything to add interest to the situation from the labour point of view, seeing that all that the delegates decided was to tabulate the proposals from the various districts regarding the new wages agreement and to send them back to the districts for further consideration, which means postponing any definite action or even definitely formulating their demands for a month or so. From the market point of view the position is very unsatisfactory, as the demand is so poor on current account and the supply of tonnage is so far short of requirements. At the end of last week there were no less than 44 idle tips at the various docks in this district, though, on Monday, as the result of arrivals, that number was reduced to 19. This, however, was a poor start for the collieries, whose standing stocks of coal are very heavy. There is a fair amount of tonnage due to come along, but it is questionable whether it will be anything like sufficient to infuse life into the loading conditions, as chartering of late has not been what can rightly be called active. A fair number of orders are held, but tonnage offering is rather on the scarce side, partly for the reason that tonnage has been sent far afield, that is in the case of the big vessels, while many of the smaller vessels have been laid up on account of the fact that ruling rates of freight are altogether unremunerative. Apart from the fact that the general demand is so slack there are a few inquiries on the market for coals for delivery over a period. Tenders have gone in for 10,000 tons of large coals and 20,000 tons of small coals for the French State Railways for delivery over three months ending May, and the Great Southern Railway of Ireland has asked for tenders on a f.o.b. basis for 120,000 tons of locomotive coals for delivery over six months commencing this month, or 240,000 tons for delivery over a period of twelve months. One of the largest steamship companies of Italy has asked for prices for 30,000 to 35,000 tons of best Admiralty large coals for delivery this month and the early part of April, and it is expected that the Norte Railway of Spain will be in the market about the end of this month for about 30,000 to 40,000 tons of steam coals.

**French Tax on Coals.**

The report that the French Chamber of Deputies had on Saturday last adopted an article in the Finance Budget imposing a tax on imported coal and coke caused some perturbation in this district, seeing that trade is difficult enough with France at the present time. It appears, however, that the tax in question proposed, of 2.50 francs for steam coal and 10 francs on anthracite, is to replace the existing tax of 1.10 per cent. which accrues to the profit of the State for all sales operations. There is some uncertainty as to how it is to be exactly applied, but fears of local exporters that trade with France would be endangered have been to a large extent allayed by the fact that the proposed tax is not directed solely against coals from this country, inasmuch as it is to apply to business in all coals, including French, German and any other coals, and furthermore some doubts are entertained whether it will become law, as the proposal has only passed the first House, and it is reported that considerable opposition is being organised against the new tax.

**Tin-plate Trade Items.**

It is announced that the new tin-plate mills to be erected at the Crumlyn Burrows, Swansea, by the Glamorgan Tin-plate Company, are to be constructed by Sir William Arrol and Co. at their works near by. This work is to be placed in hand at once, and no less than 1500 tons steel work will be needed. The decisions arrived at recently by the joint conference of makers and merchants in London have been ratified by the South Wales tin-plate makers. They allow the commission in future to merchants at 1½ per cent., which places them on the same footing with the South Wales Tin-plate Corporation, but in the case of home buyers the commission is to be ½ per cent. The idea of an approved list of merchants has been abandoned. In order to encourage trade the minimum basis price for tin-plates has been reduced from 23s. to 22s. 1½d. per basis box f.o.b. Bristol Channel ports, while tin-plate bars have been correspondingly reduced to £7 17s. 6d. per ton less the usual rebate of 7s. 6d. per ton. This reduction has been agreed upon by the Stabilisation Committee, which is representative of the whole tin-plate and tin-plate bar makers in the industry, as the result of giving serious consideration to the existing condition of the industry.

**Current Business.**

The general tone of the steam coal market has not appreciably improved, and the main feature continues to be the unevenness of prices, as the result of the individual position of collieries being so varied and weak for spot shipment owing to the quantity of coals standing being so heavy. One or two of the superior grades of Admiralty large coal are in a fairly comfortable position for orders and ready tonnage, but others are much less fortunate, and lower qualities of coals find it difficult to secure prompt orders, with the consequence that prices are on the whole easy. The reduction of output brought about by many collieries working irregularly keeps the supply of smalls down, so that their values remain fairly steady, especially in the case of the better descriptions. Anthracite coals show no change, but an improvement is looked for shortly when shipments to Canada are commenced on the re-opening of the river St. Lawrence some time next month. Already a fair amount of tonnage has been taken up to lift coals over the season, one firm having chartered vessels to load 120,000 tons.

## LAUNCHES AND TRIAL TRIPS.

THISBE, steel screw collier; built by the Blyth Shipbuilding and Dry Docks Company, Limited; to the order of G. Lamy and Co.; dimensions, 271ft. by 37ft. 8in. by 18ft. 7in.; to carry 2420 tons. Engines, triple-expansion, 21in., 34in., 56in. by 36in. stroke; constructed by the North-Eastern Marine Engineering Company, Limited; launch, February 10th.

ELMBANK, twin-screw motor vessel; built by Harland and Wolff, Limited; to the order of Andrew Weir and Co.; dimensions, 434ft. by 53ft. 9in. by 37ft.; 5200 gross tonnage. Engines, two sets of six-cylinder motors; constructed by the builders; launch, February 12th.

SANTHIA, passenger and cargo steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the British India Steam Navigation Company, Limited; dimensions, 451ft. by 57ft. 9in. by 36ft. 6in.; 9500 tons deadweight. Engines, triple-expansion driving twin screws; constructed by the builders; trial trip, February 18th.

INANDA, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Charente Steamship Company, Limited; dimensions, 406ft. 6in. by 52ft. by 31ft.; to carry 6850 tons. Engines, quadruple-expansion four-cylinder inverted reciprocating type; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, February 24th.

KATHLEEN, passenger ferry steamer; built by J. I. Thornycroft and Co., Limited, to the order of the Crown Agents for the Colonies; dimensions, 123ft. 9in. by 25ft. Engines, two sets of compound surface-condensing, 11¾in., 24¾in. by 16in. stroke, pressure 150 lb.; constructed by the builders; launch, February 24th.

WAWA, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Bragman Bluff Lumber Company; dimensions, 265ft. by 38ft. wide. Engines, triple-expansion; constructed by the builders; launch, February 24th.

FEDERIKO GLAVIC, steamer; built by Workman, Clark and Co., Limited, to the order of Dubrovacka Parobrodska Plovidba; dimensions, 435ft. by 54ft. 6in. beam; 5300 gross tons. Engines, inverted direct-acting triple-expansion; trial trip, February 25th.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, March 2nd, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Mr. Frank Scudder for his valuable gift of specimens prepared by Faraday for his research on gold films. Mr. J. Berry, Mr. T. J. Cheater, Miss E. A. Fletcher, Professor A. Fowler, Mr. F. H. Hamilton, Dr. H. Hartley, Dr. J. C. Hunsaker, Mr. A. Jaffe, Lady Jones, Mrs. M. J. Moberly, Mr. P. J. Neate, Mr. A. L. Patterson, Mr. H. C. Pridmore, Mr. Harold Samuel, Lady Schooling, Mr. H. Gordon Selfridge, jun., Mr. R. F. Sharpe, Rev. W. Hodson Smith, Mr. E. H. Storer, Mrs. W. J. Tennant, and Miss Ida Woodward were elected members.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. Coast— | |
| Native | 17/6 to 24/- |
| (1) Spanish | 23/- |
| (1) N. African | 23/- |
| N.E. Coast— | |
| Native | — |
| Foreign (c.i.f.) | 22/- |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) Scotland— | | |
| Hematite | 4 12 6 | — |
| No. 1 Foundry | 4 11 6 | — |
| No. 3 Foundry | 4 9 0 | — |
| N.E. Coast— | | |
| Hematite Mixed Nos. | 4 5 0 | 4 5 0 |
| No. 1 | 4 5 6 | 4 5 6 |
| Cleveland— | | |
| No. 1 | 4 3 6 | 4 3 6 |
| Silicious Iron | 4 3 6 | 4 3 6 |
| No. 3 G.M.B. | 3 18 0 to 3 18 6 | 3 18 0 to 3 18 6 |
| No. 4 Foundry | 3 17 6 | 3 17 6 |
| No. 4 Forge | 3 16 6 | 3 16 6 |
| Mottled | — | — |
| White | — | — |
| Midlands— | | |
| (3) Staffs.— | | |
| All-mine (Cold Blast) | 10 10 0 | — |
| North Staffs. Forge | 3 17 6 | — |
| ,, ,, Foundry | 4 7 6 | — |
| (3) Northampton— | | |
| Foundry No. 3 | 3 14 0 to 3 15 0 | |
| ,, Forge | 3 9 0 to 3 10 0 | |
| (3) Derbyshire— | | |
| No. 3 Foundry | 3 19 0 to 4 0 0 | |
| Forge | 3 15 0 to 3 16 0 | |
| (3) Lincolnshire— | | |
| No. 3 Foundry | 4 2 6 | — |
| No. 4 Forge | 3 17 6 | — |
| Basic | 4 0 0 | — |
| (4) N.W. Coast— | | |
| N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 5 0 0 (a) / 5 5 0 (b) | — / — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| Scotland— | | |
| Crown Bars | 12 0 0 | — |
| Best ,, | — | — |
| N.E. Coast— | | |
| Common Bars | 12 0 0 | — |
| Lancs.— | | |
| Crown Bars | 13 0 0 | — |
| Second Quality Bars | 12 0 0 | — |
| Hoops | 15 0 0 | 14 15 0 |
| S. Yorks.— | | |
| Crown Bars | 13 0 0 | — |
| Best ,, | 13 10 0 | — |
| Hoops | 14 10 0 | — |
| Midlands— | | |
| Crown Bars | 12 15 0 | — |
| Marked Bars (Staffs.) | 15 0 0 | — |
| Nut and Bolt Bars | 11 15 0 | — |
| Gas Tube Strip | 13 0 0 to 13 2 6 | — |

## STEEL.

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) Scotland— | | |
| Boiler Plates | 13 0 0 | — |
| Ship Plates, ¾in. and up | 9 15 0 | — |
| Sections | 9 10 0 | — |
| Steel Sheets, 3/16in. to ¼in. | 12 0 0 | — |
| Sheets (Gal. Cor. 24 B.G.) | — | £18 0 0 |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. Coast— | | |
| Ship Plates | 9 5 0 | — |
| Angles | 9 0 0 | — |
| Boiler Plates | 13 0 0 | — |
| Joists | 9 5 0 | — |
| Heavy Rails | 9 10 0 | — |
| Fish-plates | 13 0 0 | — |
| Channels | 10 5 0 | £9 to £9 5 |
| Hard Billets | 9 10 0 | — |
| Soft Billets | 8 10 0 | — |
| N.W. Coast— | | |
| Barrow— | | |
| Heavy Rails | 9 0 0† | — |
| Light ,, | 9 5 0 to 9 10 0 | |
| Billets | 8 0 0 to 11 0 0† | |
| Manchester— | | |
| Bars (Round) | 9 15 0 to 10 0 0 | |
| ,, (others) | 9 10 0 to 9 15 0 | |
| Hoops (Best) | 15 5 0 | 15 0 0 |
| ,, (Soft Steel) | 13 15 0 | 13 10 0 |
| Plates | 9 10 0 to 9 15 0 | |
| ,, (Lancs. Boiler) | 13 0 0 | — |
| Sheffield— | | |
| Siemens Acid Billets | 11 10 0 | — |
| Bessemer Billets | 13 0 0 | — |
| Hard Basic | 9 10 0 | — |
| Intermediate Basic | 9 0 0 | — |
| Soft Basic | 8 0 0 to 8 5 0 | |
| Hoops | 12 0 0 | — |
| Soft Wire Rods | 11 0 0 to 11 10 0 | |
| Midlands— | | |
| Small Rolled Bars | 9 0 0 to 9 15 0 | |
| Billets and Sheet-bars | 7 0 0 to 7 10 0 | |
| Sheets (20 W.G.) | 11 10 0 to 12 0 0 | |
| Galv. Sheets, f.o.b. L'pool | 16 12 6 to 16 15 0 | |
| Angles | 9 5 0 | — |
| Joists | 9 5 0 | — |
| Tees | 10 5 0 | — |
| Bridge and Tank Plates | 9 15 0 | — |
| Boiler Plates | 13 10 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| Swansea— | |
| Tin-plates, I.C., 20 by 14 | 22/1½ to 22/9 |
| Block Tin (cash) | 251 5 0 |
| ,, (three months) | 254 10 0 |
| Copper (cash) | 64 2 6 |
| ,, (three months) | 65 2 6 |
| Spanish Lead (cash) | 37 8 9 |
| ,, (three months) | 36 5 0 |
| Spelter (cash) | 36 1 " |
| ,, (three months) | 35 10 0 |
| Manchester— | |
| Copper, Best Selected Ingots | 69 0 0 |
| ,, Electrolytic | 70 0 0 |
| ,, Strong Sheets | 95 0 0 |
| ,, Tubes (Basis Price) | ‡ 0 1 1½ |
| Brass Tubes (Basis price) | ‡ 0 1 0½ |
| ,, Condenser | ‡ 0 1 2½ |
| Lead, English | 40 0 0 |
| ,, Foreign | 38 10 0 |

‡ A fall is expected during the week.

## FERRO ALLOYS.

*(All prices now nominal.)*

| | Per Ton. | Per Unit. |
|---|---|---|
| Tungsten Metal Powder | 1/8½ per lb. | |
| Ferro Tungsten | 1/4½ per lb. | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £24 0 0 | 8/- |
| ,, 6 p.c. to 8 p.c. ,, | £23 10 0 | 7/9 |
| ,, 8 p.c. to 10 p.c. ,, | £23 0 0 | 7/6 |
| ,, Specially Refined | | |
| ,, Max. 2 p.c. carbon | £42 10 0 | 16/- |
| ,, ,, 1 p.c. ,, | £52 0 0 | 17/- |
| ,, ,, 0.75 p.c. carbon | £58 0 0 | 19/- |
| ,, ,, carbon free | 1/5 per lb. | |
| Metallic Chromium | 4/- per lb. | |
| Ferro Manganese (per ton) | £15 for home, £15 for export | |
| ,, Silicon, 45 p.c. to 50 p.c. | £12 10 0 scale 5/- per unit | |
| ,, ,, 75 p.c. | £20 5 0 scale 6/- per unit | |
| ,, Vanadium | 17/- per lb. | |
| ,, Molybdenum | 7/3 per lb. | |
| ,, Titanium (carbon free) | 1/- per lb. | |
| Nickel (per ton) | £175 | |
| Cobalt | 10/3 per lb. | |
| Aluminium (per ton) | £130 | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| Lanarkshire— | |
| (f.o.b. Glasgow)—Steam | 16/6 |
| ,, ,, Ell | 18/3 |
| ,, ,, Splint | 19/- to 22/- |
| ,, ,, Trebles | 16/6 |
| ,, ,, Doubles | 15/3 |
| ,, ,, Singles | 14/- |
| Ayrshire— | |
| (f.o.b. Ports)—Steam | 16/6 |
| ,, ,, Splints | 19/- |
| ,, ,, Trebles | 16/6 |
| Fifeshire— | |
| (f.o.b. Methil or Burntisland)—Steam | 14/6 to 17/- |
| Screened Navigation | 23/- |
| Trebles | 15/6 to 17/- |
| Doubles | 14/6 to 15/- |
| Singles | 13/9 |
| Lothians— | |
| (f.o.b. Leith)—Best Steam | 16/- |
| Secondary Steam | 15/3 |
| Trebles | 15/3 |
| Doubles | 14/6 |
| Singles | 13/6 |

### ENGLAND.

| | |
|---|---|
| (8) N.W. Coast— | |
| Steams | 28/- |
| Household | 45/- to 58/4 |
| Coke | 30/- |
| Northumberland— | |
| Best Steams | 18/6 |
| Second Steams | 17/6 |
| Steam Smalls | 10/9 |
| Unscreened | 15/6 to 16/6 |
| Household | 23/6 to 25/- |
| Durham— | |
| Best Gas | 21/- |
| Second | 17/9 to 18/- |
| Household | 23/6 to 25/- |
| Foundry Coke | 23/- to 23/6 |

| Sheffield— | Inland. | Export. |
|---|---|---|
| Best Hand-picked Branch | 30/- to 33/- | — |
| Barnsley Best Silkstone | 26/- to 28/- | — |
| Derbyshire Best Brights | 26/- to 31/- | — |
| ,, ,, House | 24/- to 26/- | — |
| ,, ,, Large Nuts | 22/6 to 25/- | — |
| ,, ,, Small | 14/- to 16/- | — |
| Yorkshire Hards | 18/- to 22/- | — |
| Derbyshire ,, | 18/6 to 22/- | — |
| Rough Slacks | 10/- to 12/6 | — |
| Nutty ,, | 8/6 to 10/- | — |
| Smalls | 4/- to 6/6 | — |
| Blast-furnace Coke (Inland)* | — | — |
| ,, ,, (Export) | f.o.b. | 20/9 to 21/9 |

### (9) SOUTH WALES.

| Cardiff— | |
|---|---|
| Steam Coals : | |
| Best Smokeless Large | 26/3 to 27/- |
| Second ,, ,, | 25/- to 26/- |
| Best Dry Large | 25/6 to 26/- |
| Ordinary Dry Large | 24/- to 24/6 |
| Best Black Vein Large | 24/- to 24/6 |
| Western Valley ,, | 23/- to 24/- |
| Best Eastern Valley Large | 23/- to 24/- |
| Ordinary ,, ,, | 22/6 to 23/- |
| Best Steam Smalls | 16/- to 16/6 |
| Ordinary ,, | 13/- to 15/- |
| Washed Nuts | 22/- to 28/- |
| No. 3 Rhondda Large | 27/- to 27/6 |
| ,, ,, Smalls | 17/- to 18/- |
| No. 2 ,, Large | 22/- to 23/- |
| ,, ,, Through | 18/- to 20/- |
| ,, ,, Smalls | 11/- to 13/- |
| Foundry Coke (export) | 40/- to 47/6 |
| Furnace Coke (export) | 25/- to 30/- |
| Patent Fuel | 24/- to 26/6 |
| Pitwood (ex ship) | 24/6 to 25/- |
| Swansea— | |
| Anthracite Coals : | |
| Best Big Vein Large | 43/6 to 45/6 |
| Seconds | 32/6 to 35/- |
| Red Vein | 30/- to 32/6 |
| Machine-made Cobbles | 45/- to 50/- |
| Nuts | 50/- to 52/6 |
| Beans | 44/- to 45/- |
| Peas | 20/- to 23/6 |
| Breaker Duff | 9/- to 9/6 |
| Rubbly Culm | 9/6 to 10/3 |
| Steam Coals : | |
| Large | 22/- to 24/- |
| Seconds | 21/- to 22/- |
| Smalls | 10/- to 13/- |
| Cargo Through | 16/- to 19/- |

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated.

coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

# French Engineering Notes.

*(From our Correspondent in Paris.)*

### The German Treaty.

SINCE the failure of the negotiations for a treaty of commerce between France and Germany closed the German market to French products the situation of the manufacturing industries has been going from bad to worse. The crisis is more particularly felt in Alsace-Lorraine, but it is fairly general throughout the country. The exports to Germany under cover of the Treaty of Versailles were so considerable that they were largely responsible for the prosperity which, for a time, encouraged a great industrial development, but now that very little is being sent to that country and there is a restriction of buying elsewhere, French manufacturers are seeing the necessity of coming to some arrangement, even at the expense of granting concessions that, until recently, were regarded as out of the question. On the negotiations being resumed the general lines of a commercial understanding, whereby there is to be a temporary arrangement pending the drawing up of a permanent treaty as soon as both countries have settled upon their respective fiscal tariffs, were laid down. The Germans are to benfit from the minimum tariff for a large number of goods and will eventually be granted the most-favoured-nation treatment, although the full concessions will only take effect progressively over a fairly long period. Important concessions have been made on the part of Germany with regard to the products of Alsace-Lorraine. The arrangement, if confirmed, will necessarily modify the future economic policy of this country, since the liberal treatment meted out to Germany must constitute the basis for negotiations elsewhere, and in view of the present situation it seems inevitable that there must be some relaxation of the rigid protectionist policy which manufacturers have been seeking to impose.

### German Competition.

The closing of the German market and the supplying of German manufactured goods for reparations are having an unexpected and unsatisfactory effect upon many industries. Being unable to dispose of raw material to Germany, producers have been offering supplies at low prices in other markets, and as prices at home have been declining they have succeeded in combining for their maintenance, it being understood that the three big firms, which refused to enter into the combination so long as there was a question of distributing orders, have given their adhesion on the understanding that the syndicate will only, for the time being at any rate, deal with the question of selling prices. Consequently, a syndicate has been formed under the title of the Office des Statistiques des Produits Métallurgiques, including all the producers of pig iron, blooms and billets, some of the rolling mills and probably the sheet and plate makers. The result of this combination is an immediate advance in prices on the home market. Consumers view this combination with mixed feelings, and manufacturers fear that their production costs will be still further increased at a time when the situation is seriously compromised by the importation of German goods on account of reparations. While German firms have to supply 4000 trucks the French wagon builders learn that many of the orders which were to have been distributed at home have been cancelled and that very little work will be given out this year. Now the electrical and hydraulic engineering firms are up in arms against the proposal to require Germany to supply the material necessary for rural electrification. The legislators argue that this is a matter of national interest, and that as money is not available for the purchase of the material at home there is no alternative but to procure it from Germany, which will thus aid in the country's industrial prosperity.

### Apprenticeship Tax.

The rushing of a Bill through the Chamber of Deputies for imposing a further tax upon employers of 35 centimes per 100f. on all wages and salaries paid by them, the product of which is to be applied to the training of apprentices in professional schools, is another example of the hasty manner in which Socialist measures are being imposed upon industry. In principle the tax is not objected to if the revenue derived therefrom be applied in a proper manner, for it is certain that the practical suppression of the apprenticeship system has been followed by a serious dearth of skilled labour and by a lowering of the standard of those who are entitled to call themselves skilled hands. Apprenticeship in the works was abandoned when legislation hedged apprentices round with so many paternal restrictions which so interfered with the works routine that employers had to dispense with them. Professional schools were then created to provide the necessary training. Opinions differ as to the advantage or otherwise of this change, but the specialised training given in the schools is certainly not always satisfactory, especially in the sense that when a youth has finished his three years' course he often imagines that he has learned all that there is to learn. His ambition is usually to get into the drawing-office. Of late years some firms have instituted classes in their works for apprentices, but as that can only be done to a limited extent the Government is endeavouring to extend the scope of the professional schools by providing them with the necessary funds derived from the new tax on salaries and wages. Employers object to the Bill being drawn up without their being previously consulted, and they protest against the haste with which it was rushed through the Chamber. They also affirm that, while willing to contribute to the maintenance of professional schools, they are convinced that these schools will receive only a small proportion of the product of the tax, the major portion being swallowed up in the general budget, as is the case with so many other taxes levied with a definite object.

### Coal Tax.

The replacing of the tax on turnover by a fixed tax on many kinds of raw material and products, has aroused considerable opposition from coal owners, who argue that this fixed tax will fall heavily upon the poorer qualities of fuel mined in this country and will give an advantage to the better quality imported coal, the burden on which will be proportionately easier on account of the higher price.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

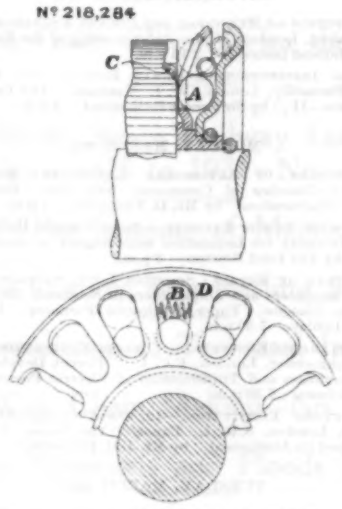
*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## DYNAMOS AND MOTORS.

218,284. June 21st, 1924.—IMPROVEMENTS IN CENTRIFUGALLY OPERATING SHORT-CIRCUITING DEVICES, *Metropolitan-Vickers Electrical Company, Limited, of 4, Central Buildings, Westminster.*

The short-circuiting device described in this specification is particularly applicable to alternating-current motors of the commutator type which start as repulsion motors and afterwards run as induction motors. When the motor runs up to speed the balls A move outwards against the action of a spiral spring B and take up the position as shown dotted. The inner

Nº 218,284



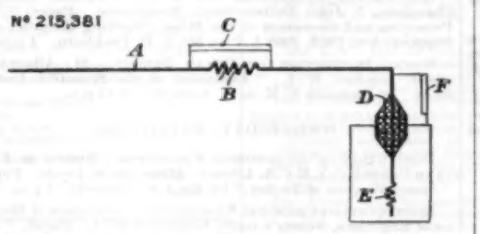

portion C of the commutator consists of insulating material on which the commutator bars are mounted. The bars are made of conducting material, such as bronze, and are mounted loos ly within the ball-retaining cage D. With increasing angular speed the balls move outwards against the spring and finally short-circuit the commutator bars. One of the main advantages of this particular form of construction seems to be that the balls retain their original condition. A motor equipped with this starting device has been started 250,000 times and the balls were found to be in the same condition as when they were first put into use.—*January 22nd*, 1925.

## TRANSMISSION OF POWER.

215,381. May 3rd, 1924.—IMPROVEMENT IN MEANS FOR PROTECTING ELECTRICAL APPARATUS FROM EXTRA HIGH TENSION OR VOLTAGE, Société Générale D'Entreprises, of 56, Faubourg St. Honoré, Paris.

The object of the apparatus described in this specification is to protect electrical apparatus connected to an aerial, subterranean or other line from excess of tension. Referring to the

Nº 215,381




diagram, the line as shown at A feeds into an inductance B, shunted by a resistance C. D is a condenser, which may be included in the lead-in insulator. E is another inductance which is connected to the electrical apparatus to be protected. Another resistance may be provided at F, the object of which is to pass static charges or those of low frequency. There are four other illustrations.—*January 22nd*, 1925.

## SWITCHGEAR.

227,910. October 23rd, 1923.—IMPROVEMENTS IN AND RELATING TO PROTECTIVE APPARATUS FOR ALTERNATING-CURRENT SYSTEMS, The British Thomson-Houston Company, of Crown House, Aldwych, London, W.C. 2, and Alan Stewart Fitzgerald, of Gable Lodge, Hendon-lane, N. 3.

According to this invention the combined effect of the series connected windings of two current transformers upon an additional secondary winding of one of the current transformers is neutralised by the primary winding thereof when the primary currents are of normal values, i.e., when there is no fault in the circuit that is being protected. The additional secondary winding is connected to a tripping device or protective relay, and serves to operate it in the event of the normal relationship between the primary conductors being disturbed, such as may be caused by a fault. Two secondary windings, A and B, are provided upon the core of the current transformer which has the poorer characteristics, i.e., the core C associated with the higher potential primary D. The secondary winding A of the double wound current transformer is connected with the secondary winding E of the other current transformer in such a sense that current induced in the latter winding and flowing through the former will produce in the core C of the double-wound current transformer a magnetic flux equal and opposite to that produced therein by the primary winding D when the conditions in the circuit that is being protected are normal. Under these circumstances there will be no resultant flux in the core C of the double-wound current transformer. The secondary winding B is connected to a tripping device F, which is only energised when the normal condition of the protectioned circuit

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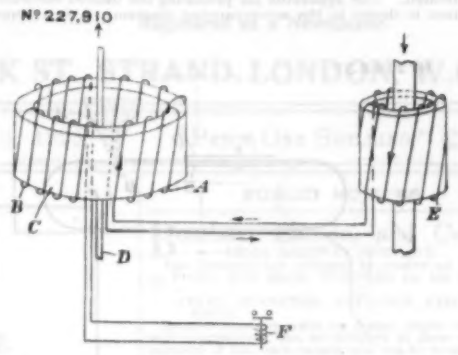


is disturbed. When it is so energised it may operate to open the main protected circuit, to give a warning signal or in any other desired manner. Owing to the relatively large current output from the current transformer associated with the circuit of the lower potential, there is no difficulty in maintaining the desired ratio of ampère turns between the series connected windings A and B.—*January 23rd*, 1925.

213,917. April 3rd, 1924.—EXCESSIVE VOLTAGE LEAK FOR HIGH VOLTAGE INSTALLATION, Emil Pfiffner, of Szasz Korolyutea 5, Budapest, Hungary.

The high voltage leak or lightning arrester described in this specification comprises a number of leaks connected in series.

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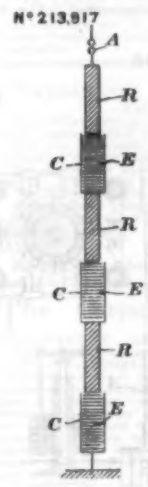


Each leak consists of a resistance R, through which the discharge can take place, and quenching electrodes E and condenser coatings C. The whole of the discharge column is preferably connected in series with a spark gap A, which allows the discharge voltage to be adjusted.—*January 29th*, 1925.

## PUMPING AND BLOWING MACHINERY.

227,342. May 20th, 1924.—ROTARY PUMPS, T. W. Edixhoven, Coolsingel 13, Rotterdam, Holland.

This pump is intended for handling heavy viscous fluids and takes the form of a hemispherical casing A. The driving shaft B lies at an angle of 45 deg. to the cover of the casing and is provided with a conical boss C having an included angle of

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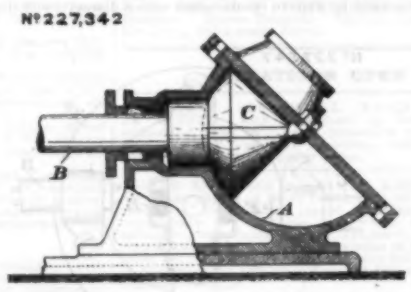


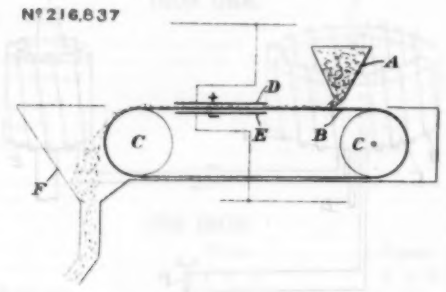

90 deg. The boss is slotted transversely, and in this slot there is arranged a semi-circular vane. The inlet and outlet ports are arranged on opposite sides of the line of contact between the cone C and the flat cover of the casing. The ports themselves are of sector shape and may be either in the cover or the casing.—*January 15th*, 1925.

## MISCELLANEOUS.

216,837. October 2nd, 1924.—METHOD OF PROTECTION AGAINST THE DAMAGING EFFECT OF ATMOSPHERIC ELECTRICITY THROUGH LOCAL IONISATION, Alessandro Artom, of N 31, Via Po, Rome.

It has been pointed out, the inventor says, that under ordinary conditions the ionisation of the air in the regions of the atmosphere is chiefly due to the ultra-violet radiations of short-wave length issued by the sun, and also to the electrons which the sun emits, owing to it being an incandescent body. According to this invention the artificial production of an ionisation analogous to that brought about by the solar powder is obtained by means of the dissemination of previously electrified powders in

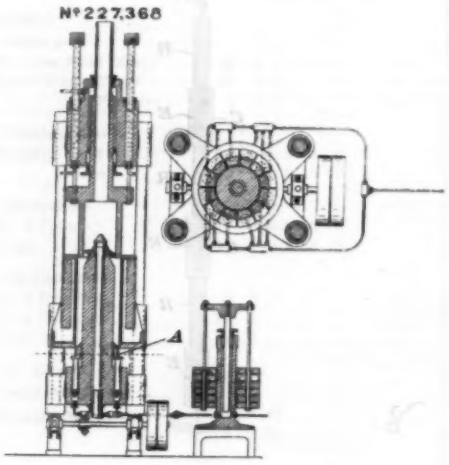
a zone to be treated, the powders consisting of finely ground dry leaves or very fine sawdust. The object of the invention apparently is to prevent the damaging effect of atmospheric electricity and particularly of hailstorm discharges by preventing local ionisation of the region in the atmosphere which is the seat of the electrical disturbance, and for the purpose of producing the ionic nucleation of the water vapour existing in the zone treated. The apparatus for producing the desired electrification is shown in the accompanying diagram. A is a hopper




which feeds the powder to be electrified on to an endless belt B, driven by pulleys C, passing between two plates D E connected with the poles of an electrostatic machine or any other continuous generator of electricity, so that the powder passing between the plates becomes strongly electrified. It then falls into a hopper F, and is either led to a blower or is fed into an insulated receiver to be utilised later. For the purpose of spreading the powder in the stormy regions aeroplanes may be used.—*January 29th*, 1925.

227,368. July 11th, 1924.—Oil Seed Presses, G. R. Schueler, 3, Ash Grove, Beverley-road, Hull.

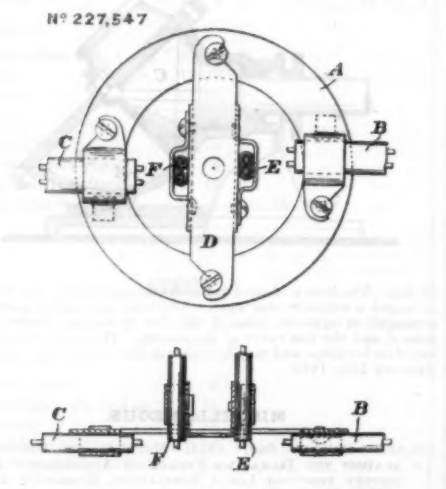
This invention relates to that type of oil seed press in which the seed is squeezed, in an annular chamber to express the oil, and the spent material is discharged from the bottom of the chamber when the pressure of the ram is increased to such an extent that means used to support the bottom cover of the chamber are overpowered. The bottom cover normally




takes the form of a ring, and then the discharge may not be complete, as the spent material may be more dense in one part of the chamber than in another, with the result that the press becomes choked. The inventor thus makes the bottom ring A of a series of sector-shaped pieces, as shown in the plan, and supports each piece by a separate hydraulic ram. Any individual piece can consequently give, and relieve the local pressure, if the press is choked, without spilling away to waste adjacent unpressed seed.—*January 15th*, 1925.

227,547. October 29th, 1923.—Improvements in Bonding Devices, Johnson and Phillips, Limited, and Herbert James Groves Webb, both of 12, Union-court, Old Broad-street, E.C. 2.

This specification describes a bonding device for metal-sheathed cables, comprising a bonding ring to which leads can be secured by clips in combination with a diametrically disposed




bridge piece to which leads at right angles or otherwise inclined to the plane of the ring are secured by suitable means. In the drawing A is the bonding ring and B and C the metal-sheathed leads secured in position by clips. The U-shaped bridge piece D is held in position by screws. Metal-sheathed cables E and F are disposed at right angles to the plane of the bonding ring and are held in position by clips in the manner shown.—*January 22nd*, 1925.

## Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### TO-DAY.

Institution of Electrical Engineers: North Midland Centre.—Hotel Metropole, Leeds. Annual dinner. 6.30 for 6.45 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Pitfalls for Patentees." 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "How to Apply for a Job, and How Not to Do It," by Mr. E. Fianders Etchells. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Rate of Man's Evolution," by Sir Arthur Keith. 9 p.m.

### SATURDAY, MARCH 7th.

Institution of Municipal and County Engineers.—Town Hall, Ealing, London, W. 5.—Joint meeting of the Eastern and South Midland Districts. 2.15 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Lecture, "The Counting of the Atoms—II.," by Sir Ernest Rutherford. 3 p.m.

### MONDAY, MARCH 9th.

Institution of Automobile Engineers: Birmingham Centre.—Chamber of Commerce, New-street, Birmingham. Paper, "Carburation," by Mr. D. Finlayson. 7 p.m.

Chadwick Public Lecture.—Inner Temple Hall, London. "The Necessity for Legislation with Regard to Smoke Abatement," by The Lord Newton. 8 p.m.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Electric Furnaces," by Mr. A. Glynne Lobley. 7.30 p.m.

Northampton Engineering College Engineering Society.—St. John-street, London, E.C. 1. "Recent Developments in the Generation and Transmission of Electric Power," by Mr. M. G. Holmes. 5.30 p.m.

Surveyors' Institution.—12, Great George-street, Westminster, London, S.W. 1. Paper, "The Smoke Nuisance in Towns and its Abatement," by Mr. J. G. Elsworthy. 8 p.m.

### TUESDAY, MARCH 10th.

Institution of Automobile Engineers.—Broadgate Café, Coventry, Coventry Graduates' meeting. Paper, "Supercharging," by Mr. S. Ethelston. 7.15 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Carburation," by Mr. D. Finlayson. 7 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Paper, "Measurements of Discharge over a Rock-faced Dam," by Professor S. M. Dixon and Mr. F. W. Macaulay. 6 p.m.

Institution of Electrical Engineers: North Midland Centre.—Technical College, Bradford. Paper, "Three-Wire Direct-current Distribution Networks: Some Comparisons in Cost and Operation," by Mr. H. W. Taylor. 7.15 p.m.

Institution of Engineers and Shipbuilders in Scotland.—37, Elmbank-crescent, Glasgow. Paper, "The Manufacture of Brass Condenser Tubes, with some Notes on an Alternative Alloy," by Messrs. G. A. Whiteman and A. Spittle. 7.30 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual general meeting. Address by Mr. H. Barringer, the retiring President. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Paper, "The Principles and Operation of the Mines (Working Facilities and Support) Act, 1923, Part I.," by Mr. J. H. Cockburn. 4 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "Evolution of the Scientific Instrument," by Professor E. N. da C. Andrade. 5.15 p.m.

### WEDNESDAY, MARCH 11th.

Institution of Automobile Engineers: North of England Centre.—Y.M.C.A. Library, Albion-place, Leeds. Paper, "Steam Wagons of To-day," by Mr. J. C. Cornock. 7 p.m.

Institution of Chemical Engineers.—Institution of Mechanical Engineers, Storey's Gate, London, S.W. 1. Paper, "Expansion and Compression Phenomena in Steam Jets," by Professor A. L. Mellanby. 8 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "The Relative Importance and Nature of Secondary Stresses in Steel Structures," introduced by Mr. J. S. Wilson. 7 p.m.

Institution of Civil Engineers.—Students' visit to the Barking Power Station of the County of London Electric Supply Company.

Institution of Engineers-in-Charge.—St. Bride Institute, Bride-lane, London, E.C. 4. Paper, "Developments in Ammonia and $CO_2$ Compressors," by Mr. E. H. Field. 7.30 p.m.

### WEDNESDAY AND THURSDAY, MARCH 11th and 12th.

Institute of Metals.—Institution of Mechanical Engineers, Storey's Gate, London, S.W. 1. Annual general meeting. For programme, see page 223. 10 a.m. each day.

### THURSDAY, MARCH 12th.

Institution of Automobile Engineers.—Training School of Vauxhall Motors, Limited, Luton. Luton Graduates' meeting. Paper, "Some Notes on British Methods of Continuous Production," by Mr. F. G. Woollard. 7.30 p.m.

### FRIDAY, MARCH 13th.

Ex-British Westinghouse Association.—Holborn Restaurant, London, W.C. 1. Seventh annual re-union dinner. 6.45 p.m.

Institute of Metals: Swansea Local Section.—Metallurgical Department of the University, Singleton Park, Swansea. General discussion. 7.15 p.m.

Institution of Electrical Engineers: London Students Section.—Anderton's Hotel, Fleet-street, London, E.C. 4. Annual dinner. 6.45 for 7.15 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, London, S.W. 1. Reports to the Cutting Tools Research Committee. "The Action of Cutting Tools," by Professor E. G. Coker; and "Experiments with Lathe Tools on Fine Cuts, and Some Physical Properties of the Tool Steels and Metal Operated Upon," by Messrs. Dempster Smith and Arthur Leigh. 6 p.m.

Junior Institution of Engineers, 39, Victoria-street, London, S.W. 1. Lecturette, "Notes on Methods of Producing Modern High-grade Machine Tools," by Mr. A. P. Bale. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "The Beginnings of the Science of Language," by Professor Gilbert Murray. 9 p.m.

### SATURDAY, MARCH 14th.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Sackville-street, Manchester. Lecture, "Oil Sand Cores," by Mr. G. Edgington. 4 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "The Counting of the Atoms, III.," by Sir Ernest Rutherford. 3 p.m.

### MONDAY, MARCH 16th.

Institution of Automobile Engineers.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "A Few Features of Early Car Design," by Mr. E. R. Caffyn. 7 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Some Notes on British Methods of Continuous Production," by Mr. F. G. Woollard. 7.30 p.m.

Institution of Structural Engineers.—Criterion Restaurant, Piccadilly, London, W. 1. Annual dinner. 7 for 7.30 p.m.

Junior Institution of Engineers: North-Western Section.—Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. "Industrial Electric Vehicles," by Mr. J. R. Oliver. 7.15 p.m.

Women's Electrical Association.—Visit to the Osram Lamp Works, Hammersmith. 2.30 p.m.

### TUESDAY, MARCH 17th.

Institute of Marine Engineers.—85/88, The Minories, Tower Hill, London, E. 1. Paper, "Motor Passenger Vessels," by Mr. A. C. Hardy. 6.30 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—The University, Leeds. Paper, "High-pressure and High-temperature Steam," by Messrs. W. R. T. Skinner and G. E. Barrett. 7 p.m.

### WEDNESDAY, MARCH 18th.

Institute of Metals: North-East Coast Local Section.—Electrical Engineering Theatre, Armstrong College, Newcastle-on-Tyne. Paper, "Electric Furnaces," by Mr. A. Glynne Lobley. 7.30 p.m.

### FRIDAY, MARCH 20th.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Paper, "Modern Transport," by Mr. S. H. Hole. 7.30 p.m.

### SATURDAY, MARCH 21st.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—College of Technology, Manchester. Lecture, "Plate Moulding and the Patternmaker," by Mr. H. Stead, 7 p.m.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

Commander Charles Worthington Craven, R.N., who has been a special director in charge of the Vickers Works at Barrow-in-Furness, has been elected on the board of Vickers Limited.

Mr. George Bradshaw has been appointed to the board of Turton Bros. and Matthews, Limited, of Sheffield. He has been for many years manager of the firm's Spring Works in Neepsend-lane, and will continue in charge of that department.

We are informed by Featherstone Hammond Partners, Limited, of 28, Victoria-street, Westminster, S.W. 1, that Mr. Brunler has made that company responsible for all negotiations connected with his internal combustion boiler, and has entrusted it with arrangements for the manufacture, supply and installation of plant.

John Thompson Water Tube Boilers, Limited, of Wolverhampton, asks us to state that it has appointed Mr. James Ritchie, of Glasgow, as the representative for Scotland for John Thompson Water Tube Boilers, Limited, and its allied companies, John Thompson (Wolverhampton), Limited, and John Thompson, (Dudley), Limited. Mr. Ritchie's offices are at 50, Wellington-street, Glasgow.

## CONTRACTS.

William Shepherd and Sons, Limited, road contractors, Milkstone, Rochdale, have just been notified that their tender for the reconstruction of Section 1 of the Inverness-Perth road has been officially accepted by the Inverness-shire County Council.

The Bradley Pulveriser Company announces that the Poplar Borough Council electricity works has ordered the Bradley three-roll mill (closed and dustless type) for the new pulverised coal plant for boiler firing now being installed at the Poplar power station.

The Sperry Gyroscope Company, Limited, of 15, Victoria-street, London, S.W. 1, has recently fitted Sperry gyro compasses to the Letitia, of the Anchor-Donaldson Line, and the Princess Marguerite, of the Canadian Pacific Line; and a Sperry gyro pilot to the Hakusan Maru, belonging to the Nippon Yusen Kaisha Company.

The Foundation Company, Limited, of Kingsway, London, W.C. 2, has entered into a contract with the London Underground Company for the construction of the southern section of the extension of the City Railway between Dorset-road (Clapham) and North Morden. The line will be partly in the open and partly in cut and cover.

Howden-Ljungstrom Preheaters (Land), Limited, 133, Helen-street, Govan, Glasgow, has practically completed the installation of an air preheater on a Woodeson boiler at Hull Corporation Electricity Works. The heating surface of the preheater is 26,680 square feet, and air will be supplied to the furnace at about 400 deg. Fah.